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MAN AGAINST GERMS

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by

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Dedicated to
DORA

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AUTHOR'S NOTES

TO IDENTIFY the tiny scraps of life that threaten our existence, I have used the word "germs." It is sanctioned by the passing of centuries for it was in 1546 that Hieronymus Fracastorius first wrote of the "germs" of disease.

In this work, I would have liked to find space for all the true tales of men and women who searched for or were sought by the germs of disease.

I have narrated the story of but one of the species of germs of love; others may be told at another time.

I have referred briefly to the underrated false germs of Pfeiffer, and said nothing about other germs that strangle children or bring them scarlet death or grow into an impenetrable curtain over their eyes or mutilate them while unborn in their mother's womb.

I have not told the remarkable tale of the germs of malaria, how they destroyed men in the Old World while the cure for malaria grew unused on trees in the New World where no malaria existed.

I have not mentioned the many germs of the tropics and Orient, the diseases with names that smell of incense and murmur of dark incantations.

For the present, there remains untold the sad triumph of young Daniel Carrion who died in an obscure Peruvian valley.

There are extinct germs that once killed millions of people, there are germs of madness, germs of sleeping and death, germs that cause a ludicrous disease; but none of their stories will be written in these pages.

All the stories of germs and men are fascinating, I would like to write them all!

The contributions of the many men and women in science and medicine from whose works my material has been derived are humbly acknowledged.

My sincere thanks to the trustees of the Eugene F. Saxton Memorial Trust who believed in this book from its primitive beginnings, whose award eased the manifold burdens of authorship and encouraged and stimulated its completion.

And I am grateful for the many courtesies of the librarians and their assistants at the libraries of the New York Academy of Medicine and Columbia University, as well as for the patient skill of Ann Kopeloff, who converted scribbling into neatly typed manuscript.

A. L. B.

CHAPTER I

OF GERMS AND MEN

WE SHARE this world with an incredibly vast host of invisible things. All about us the living germs abound. Their ways are strange, their life is alien, and their infinite populations overlap and encroach upon our human world. Germs are everywhere, wherever there are men, and they crowd densely in many places where men have never been. They float in the air, they rest in the soil, they swim in the saline waters of the seas and in the sweet waters of lakes and rivers. They squirm in the ooze that carpets the deepest ocean bottoms, they scale inaccessible mountain peaks and soar above into the thinning atmosphere and even far beyond into the airless spaces between planets and stars. They inhabit the frigid waters and glacial ice of polar wastelands; they thrive in the boiling waters of hot springs and geysers.

Some germs are pallidly colourless, others vividly reflect all the hues of the spectrum, and many have tints that are not apparent in the rainbow. There are red germs and black germs, purple, green, blue and yellow. There are also germs in shades of ochre, umber, sienna and terra cotta. Some are colourless, but in the culture nutrients around them they manufacture brilliant dyes of bronze vermilion or blood red, or translucent azure, glittering gold yellow or fluorescent indigo. And some germs, in lieu of colour, emit their own cold white light like fireflies for a purpose known only to mother nature.

A few germs live intimately and benignly among us, adding flavour to our butter and cheese, preserving our pickled herring and our cabbage, brewing our beer, making some of our industrial chemicals, many of our vitamins and all of our anti-biotic drugs.

Most germs live unostentatiously; they are indifferent to, and aloof from, men. They reproduce their kind unnoticed, they beget billions of their generations while a dynasty changes in China or a war rages in Europe. These are the germs that feed on swamp gases, on petroleum oil, or iron rust, or sulphur or arsenic. Many of them convert the nitrogen of the atmosphere

into food for plants and eventually into food for humans. Many of them live on the remains of plants and animals that once were alive; they are beneficent scavengers, removing the dead to make room for the living. These germs struggle for existence among themselves in a mighty and microscopic competition for food. They engage in silent encounters that continue endlessly all over the world. Each moment, billions of germs die and billions more are born.

There are other germs which struggle not with each other but with other species of living things. These are the parasites which live on the living bodies of other germs, plants or animals.

All life survives by the urge to live, and in the meagre insensate life of the parasite germs of human disease the urge to live is as strong as in humans themselves. These germs are the infamous seeds of pestilence, of fever and sweat, of pox and flux that enter into the human body to mar and maim, to live by the disease they cause. Their mode of life demands that they invade men's bodies or die. They invade, and the body resists their invasion with fever and illness, visible signs of disease as the host reacts and defends itself. Innumerable encounters in the past over millenniums of selection and evolution have strengthened the defences of the human body; selection and evolution have also strengthened the invasiveness of germs. When death follows disease, it is a misfortune for both germs and men. For death is not sought by germs and it is resisted bitterly by their victim. Each human death by germ invasion is a holocaust, for, when a man dies of disease, his germs are buried with him.

Germs of disease were not always on earth, but neither were men. Germs were created first, and, when men arrived, germs were waiting to infect them.

Three billion or more years ago, the earth was created. The manner of its creation is accepted by theologians everywhere, and disputed with a certain lofty bitterness in the rarefied atmosphere of the highest astronomical and astrophysical circles. Many scientific theories have been proposed by astronomers and astrophysicists to explain the earth's creation, some simple and some complex, and there are always to be found other astronomers and astrophysicists to dissent and advance other theories. And behind the disputants hover the mathematicians. They never advance theories of their own. Instead, they use cryptic signs and symbols to prove that creation could not possibly have happened in this way or that, and they destroy the most ingenious of theories with their deadly mathematics. In recent years, mathematicians have been remarkably busy.

They have demonstrated mathematically that all the many theories of the earth's creation are mathematically impossible. All the theories have been rejected, from which we may infer that mathematically the earth was never created and therefore does not exist.

But we prefer to believe otherwise. All of us non-mathematicians are convinced that the earth was created and does exist and any of us are free to select from among many theories the kind of creation we prefer.

It may have happened, perhaps it did happen, in this way—

Three billion or more years ago, the earth was created but existed without life. The earth had just been formed from the sun in a stupendous cataclysm that had torn away an immense fragment of solar substance and hurled it millions of miles into space. The fiery mass moved away swiftly, then more slowly, until, attracted by the force of solar gravity, it began to revolve around the sun from which it had been created. As it revolved, it also rotated about its own axis. It revolved and rotated, the revolutions marking the years and the rotations marking the days, and millenniums passed while the flaming gases cooled and congealed into a crudely formed sphere of white-hot molten rock and flowing metal enclosed within a fiery atmosphere. Eons went by and the cooling continued, each eon marking an infinitesimal lessening of the fire within the seething earth. Eventually a crust of slag began to form, floating upon a fluid inferno. Slowly, islands of solidified rock emerged and new islands formed and grew and coalesced. The surface of the earth became solid. There was no life on earth, although the raw materials of which all living matter is composed were present, for life could not exist at a temperature of thousands of degrees Fahrenheit. And water existed solely in the form of superheated steam which saturated the glowing atmosphere.

The earth continued to rotate and revolve for many more hundreds of millenniums. Imperceptibly the crust of the earth cooled and thickened and contracted to constrain the restless pressures beneath it. Periodically, the fiery interior heaved up and parted the crust, briefly exposing the vast furnace beneath. Earthquake tremors upturned continents, volcanoes exploded everywhere belching fire and molten rock high into the flaming air. Time, measured in myriads of centuries, moderated the heat and quenched the flame, lessened the earthquakes and suppressed the freely spurting volcanoes. Nature had all eternity at her disposal; millions of years were available to thicken the crust of the earth and cool its fervid interior. The shape of the earth

began to assume stability of form, order replaced chaos, the cleavage between heaven and earth appeared as the dust and fumes settled, and sunlight fell briefly and dimly on bleak lands.

As the earth and its atmosphere cooled, colourless superheated steam condensed into white vapour, then into clouds that thickened and darkened and, turning into water, poured down upon a waterless earth. Now the rays of the sun were once again hidden, and the skies remained overcast for long millenniums, while rain descended unceasingly. The rain fell not in gentle drops, but violently, in solid columns of water everywhere, and the water was blown in every direction by immense gusts of wind. For thousands of years the air seemed not to exist. There was only steaming rock below and water falling from above. Torrential rains striking the glowing earth vaporised and boiled up into clouds, to cool and fall and rise again in endless cycles.

The flow of water from heaven to earth was accompanied by dazzling light and deafening sound, but there was no living thing to see or hear the wonder of creation. Gigantic thunderstorms accompanied the gushing waters, and lightning flashes overlapped continuously in electric brilliance, glaring brightly over the surface of the earth and reflecting prismatically from the water that was everywhere. It was ceaseless lightning, with thunder in blasts of sound that overpowered the reverberations of earthquakes and the explosions of immense volcanoes, that subdued the pandemonium of the torrential rains and the monstrous shrieking of the hurricanes.

As the rain persisted, the waters cooled the earth, drenched the raw crags and rocky plains and drained off to settle into the giant wrinkles of the earth's crust. Great seas and vast oceans were created.

The elements of life, those raw materials of which all living matter is composed, were present, unassembled, in the waters of the newly-formed seas, in the dust expelled from spurting volcanoes, in the gases that swirled in the turbulent air, in the solid matter that had crystallized from the incandescent substance of the sun; for the elements of life are the elements of the sun and of the earth. The climate had become compatible with the existence of living matter, and there was lightning, the catalyst of all life-to-be. It was time for life to begin. Amid the din of crashing earthquakes and erupting volcanoes, in the roar of wind and water, surrounded by tumult and commotion, life was created inconspicuously within a bolt of lightning. The primitive seeds of life were moulded from water and dust and gases, which combined with each other and became endowed with the rudiments of life. Carbon, nitrogen, oxygen and hydrogen,

sodium, potassium, calcium and phosphorus, essential metals and minerals, all the non-living elements that make up the mortal garments of the living soul, these the electricity of the lightning catalysed and fused into organic molecules. Washed down with floods of water and dropped into the warm depths of the shallow seas, the seeds of life germinated and matured, and over many millenniums developed into living molecules, into the first living things on earth. They became the oldest and the smallest of germs, which our science has named the *viruses*.

This is how the creation of life may have taken place. No one can prove that it actually happened this way, nor can anyone prove that it happened any other way. This account is in accord with our present level of knowledge in the science of all living things. There are many questions about the creation of life which science discusses informally but cannot answer. Did the creative spark of lightning form life just once or did it continue to create life repeatedly? Do the modern flashes of lightning produce new life today? Our science does not know, for our knowledge is imperfect and imperceptible before that which is yet to be learned. Nature created life two billion years ago, and for two billion years she has been changing and making more complex the structure of living matter. Science has studied the chemistry of protoplasm for scarcely a century.

In their primeval state, the viruses lived meagrely in the seas on the food provided by dissolved iron and sulphur and on volcanic gases that bubbled through the waters. They made use of simple chemical reactions yielding modest surges of energy sufficient for their maintenance and to supply sparingly the vital energy needed for growth and reproduction. As the years passed, the existence of the newly-created viruses became difficult. The earth and its climate continued to cool, the seas became more saline from the washing of the lands by rains and rivers, volcanic gases became scarce as volcanic action diminished. The viruses were then the sole representatives of life upon earth; they were the fount from which all other forms of life were to be derived. If they had been unable to adapt to the environment that had grown increasingly hostile, if they had succumbed and became extinct, perhaps no form of life would now exist upon the earth.

Some viruses survived by attaching additional chemical elements and compounds to themselves, and grew to an enormous size. By synthesising chlorophyll they became plants and lived on the energy derived from the rays of the sun.

Other viruses also grew in size and complexity of structure, and became animals that ate plants and other animals. They

learned to swim in the sea, and as they increased in numbers many left the sea to overrun the land. Some of the animals eventually became men. By indirect and involved lineage, from the primitive viruses came Aristotle, Da Vinci, Mozart, Fra Angelico, Shakespeare, Dante, Darwin and Einstein.

There were other viruses that grew only slightly larger, evolving into many species of larger germs that, at the beginning, were all scavengers of dead animals and plants. Later some of these viruses learned to invade living plants and animals and became germs of disease.

Among the primitive viruses, there were some that did not grow at all, that retained their intangible form of life—a single living molecule. They survived and exist today as the smallest and oldest germs. When in early times they suffered from the competition of coarser forms of life, they learned to become parasites upon their competitors. All viruses known to science developed into a kind of half life, needing the full life of some other species in order to survive. All modern viruses are obligate parasites; they can live only by the disease and death of other forms of life. They are all germs of disease.

After the germs of disease were created, they diverged in form and mode of life. They were favoured by nature—to mother nature, no mode of life among her children is ignoble—and they expanded into an innumerable variety of species. They became skilled parasites on all other forms of life. In earlier times, they attacked dinosaurs and sabre-toothed tigers, giant ferns and mosses; later they invaded the elephant and the whale, modern trees and the vast kelps that blanket the surface of the sea. Today, they attack man's cattle and his corn; they attack man himself.

Germs of disease exist today in direct lineage from the first seeds of life. They are not the wisest of nature's creations, but wisdom is an innovation that has existed for only a day on the calendar of nature, and there can be no certainty that the wisdom of man will eventually triumph over disease germs and defeat their blind and stubborn will to live.

There are many ailments among men that are not germ-caused. There are muscular dystrophy, epilepsy, cerebral palsy and hæmophilia; there are the tragic multiple sclerosis, the dreaded syringomyelia, the pitiful osteomalacia, and many more of those misfortunes that alter and destroy from within the bodies of men. Each is an individual tragedy. But the influence of the diseases caused by the always-pervading alien life of germs is far more profound. When the germs of tuberculosis, leprosy,

bubonic plague, syphilis and many other pestilences of man were created, each began its history, and the history of each was interwoven with the history of man.

Germs of disease alter and destroy the bodies of men, and more, they warp human lives, they tamper with human destinies, they divert human aspirations. In the past, germs have allowed some nations to expand and have ruthlessly cut down others; they have crushed or preserved civilisations. Germs bring disaster to one marching army, and award victory by default to another. Their intervention has made proud military geniuses out of mediocre soldiers; they have humbled great emperors and brilliant generals.

But germs can do even more. They can divert research scientists from their search; they can create a confusion of right and wrong in the human mind, and make honest men into liars and charlatans.

By the simplest means, germs of disease may turn a loving father into a callous scoundrel, a complacent wife and mother into a screaming hag fleeing wildly from her family. Yet germs of disease also have aroused great compassion and self-sacrifice among ignorant peasants and made saints and martyrs out of commonplace sinners.

These are the potentialities of the germs of disease.

Despite miracle drugs and modern medicine, germs continue to pursue us. Some of their diseases are not likely to intrude into our modern existence—many kinds of pestilence have become improbable, but none is impossible, for their germs continue to exist on this earth. Nor can any of us shut himself away entirely from all the wildlife that roams in the invisible realm of germs. Everywhere in the world, germs of disease continue their blind and stubborn warfare against mankind.

CHAPTER II

THE AVID GERMS FROM INDIA

CHOLERA OFTEN simmered and boiled in India and so it had been for interminable centuries. Cholera was described in the most ancient of Sanskrit writings and in the ritual for the worship of Oola Beebee, the goddess of cholera. For many cen-

turies, thousands and millions died from the disease, scarcely missed by mother India and unnoticed by Western civilisations.

The first knowledge of cholera came to Europe in 1325. The epidemic of that year had been severe in Delhi, killing many of the nobility and prostrating the divine Sultan himself. There had been consternation over all India, and, as tales recounted by travellers, the news had penetrated into some parts of Europe. More news of cholera came to the Western World after the Portuguese colonised Goa in 1502. They warred with the ruler of Calicut, and the Calicuts suffered twenty thousand casualties, many of which the Portuguese reported "were caused by a disease which struck them suddenlike in the belly." A few years later, when the Portuguese had completely subjugated Goa and the colony was firmly established, the colonials noted with interest the events of the epidemic of 1505 and the greater outburst of cholera in 1543. Within the confines of their outposts, the Europeans were nearly as free from cholera as Europe itself, and they were able to observe without alarm and with academic curiosity the progress of the disease and its treatment. Tavernier wrote in 1648 that the hospital regimen required each patient "to drink three times daily a glass of the urine of the cow"; and D'Arta reported that cholera victims in coma were revived by pepper thrown into the eyes and the application of red-hot irons to the soles of the feet. On the healing virtues of the *togora*, prepared by Capuchin monks and consisting of coconut brandy distilled over horse dung. Fra Paolino observed that "all recovered to whom this beverage was given." Less novel to European eyes was the opium given in heavy doses to deaden pain and repress intestinal spasms, and the blood-letting repeated on some occasions thirty times in one day on the same victim.

Despite treatments and fervent prayers to Oola Beebee, cholera continued to simmer and boil in India for two centuries; the cauldron boiled at intervals and simmered in the intervening periods. The repeated epidemics were ignored in Europe, and in India the loss of thousands of souls was scarcely noticed in a land of millions, with new thousands continuing to be born daily.

Imperceptibly, outbreaks of cholera were increasing in violence, boiling up to the very rim of the cauldron. The epidemic that began in Juggernaut in 1781 spread hundreds of miles before it receded. Afterwards, thirty years of quiet elapsed; the tidal wave of cholera was massing for the inundation of 1817.

The year 1816 was dry and warm in India; the year pre-

vious had been wet and humid. It was even more wet and humid in 1817, when the rains came down incessantly and the rivers, overflowing their banks, drenched the countryside. Everywhere crops rotted and washed away, and the ever-prevailing famine of India became even more severe. To privation was added pestilence—cholera reappeared.

India was the original source of cholera, yet the cauldron had never been known to boil over. Cholera belonged to the people of India, it was their exclusive property; so said the Europeans and Americans—until 1817. For in May, 1817, the germs of cholera spilled over in India and began to journey that did not end until they had encircled the world, and many people in fine clothes dining on white tablecloths in great cities far away from the poverty and degradation of India were caught in the overflow.

Germs in waves raced to the south and the idol car of Juggernaut could not be dragged that year. The worshippers were willing but their cholera-ridden bodies collapsed and there were none who were free of the disease.

“The ‘car festival’ takes place in June or July. For weeks before the pilgrims come trooping in by thousands every day. They generally have to walk from three hundred to six hundred miles, and are always forced up to doing a full day’s journey. These are fed by the temple cooks to the number of ninety thousand; and over one hundred thousand men and women tug and strain at the car till they drop exhausted and block up the road with their prostrate bodies.

“Disease and death make havoc of the pilgrims, for they are badly lodged and poorly fed. The dead are buried in the sands, and the hillocks are covered with bones and skulls washed bare by the tropical rains. The temple kitchen has secured the monopoly of cooking for the multitude; and the food is always presented before Juggernath, and thus becomes holy food . . . it is too sacred for the least part to be thrown away. Large quantities soon undergo putrefactive fermentation, and in forty-eight hours much of it is a loathsome mass. It is consumed by someone to the very last morsel.

“Each house is built upon a mud platform about four feet high, in the centre of which is a hole which receives the filth of the household. Without windows or roof ventilation, into these caves the pilgrims are massed together. The stench is overpowering, and the heat like an oven. The rains pour down almost in solid sheets. Cholera invariably breaks out. The living and dead are huddled together, with a leaky roof above, a foul cesspool

below, and with only just as much space as they can cover lying down.

"There are also so-called corpse fields around the town on which forty or fifty bodies are often seen at a time . . . Carnivorous birds were found sitting around gorged, and wild dogs lounged about full of the flesh of men.

"In one sudden storm the bodies of poor deserted women formed a dam to the insufferable filthiness from a thousand bodies which was being washed down by the sudden shower. They were too weak to rise, and lay throwing their arms about . . .

"But on the return journey the misery of the pilgrims reaches its climax. They have been plundered by priests and landlords, and stagger along under the burdens of holy food. Some drag their weary limbs along till they drop from sheer fatigue; others crowd into the villages and halting places along the road, blocking up the streets, after the available sleeping-places are crammed to overflowing; and every night thousands have no shelter from the pouring rain. Miserable groups huddle under the trees; long lines lie among the carts and bullocks on the roadside, their hair mixing with the mud in which they lie; the bridges are covered with the sodden bodies; hundreds sit on the wet grass, not daring to lie down, and rock themselves to a monotonous chant through the long dismal night. Then their corpses lie thick around . . . forty festering bodies at one spot on the banks of one river." (J. C. Peters, *A History of the Travels of Asiatic Cholera in Asia and Europe*, 1875.)

The germs boiled over in successive waves that ran up the Ganges and did not recede until they had overrun Bengal and inundated two hundred thousand miles of land. Cholera flowed from the rivers and washed ashore, spreading inland. An invisible tide of germs diffused over the roads, where pilgrims and soldiers marched incessantly and where their paths crossed repeatedly. The roads became perilous with unseen death. In that year of cholera, when half of the pilgrims of India failed to complete their pilgrimage, their thinning ranks moved along the highways, sickening and dying as they trudged, leaving behind an intangible and stagnant current of the cholera wave. And when the troops of the Marquis of Hastings, an army of one hundred thousand vigorous men, crossed the roads where pilgrims had passed, they marched through the deadly tide. The army of Hastings never reached its destination; its soldiers were destroyed by cholera and the highways and fields for miles around were strewn with their bodies.

The worship of the goddess Oola Beebee was revived but could not stem the tide of the ways of cholera. Cannons were fired in Bombay to shock away the pestilence, tar and sulphur were burned in the streets to purify the air and purge its evil, but cholera continued to rise. The tide of germs rose and ebbed, advanced and receded, and advanced again to wash eventually upon shores thousands of miles and many years from India.

The germs of cholera were carried by men, the wave was exhausted only when the lives of men were exhausted. Always a few were spared, and when they had regenerated their numbers a new wave would start again from the original source and once more roll outward in all directions. Each cholera wave was composed of individual germs loosely joined together into thousands and millions of *nodes*—a giant diffuse monster that descended upon and enveloped the land wherever there were men, each node concentrated within the twisted body of a human dying painfully of cholera. Between the nodes, the germs were scattered thinly, carried by men, spread by their filth, aided by their poverty, abetted by their ignorance.

This was the *first* wave of cholera to boil over. It overflowed the vast land of India, crossed the northern frontiers into Afghanistan and central Asia and spread to the east across Burma. The germs entered Siam, and at Bangkok the Siamese looked fearfully to the sea from where cholera had come, and held great religious rites to exorcise the monster fish that had arisen from the waters of the Gulf of Siam to spew pestilence upon the shore. The germs penetrated east to Canton, Nanking, Peking and over all of central China, and the Chinese as they died gazed fatalistically at the great yellow fog from the Yellow Sea which they believed had brought death upon them. The germs travelled south to Singapore and sailed over the seas to Sumatra, the Celebes, to Java, Borneo, the Philippines and to the many islands that dotted the South Pacific.

To the west of India, the germs moved along the pilgrim routes. The boats from Bombay to Bassorah to Baghdad carried cholera and sick and dead pilgrims. On the land the wave rolled across Persia and Syria, into Arabia, to the Persian Gulf and the sacred city of Mecca. There the wave diverged. A minor stream swirled south into Africa and destroyed one hundred and fifty thousand Egyptians, while the main tide crossed the Caucasus and the Volga, reaching Moscow and Europe after twelve years of travel.

All Europe knew cholera or thought they knew it. The people had been visited familiarly and frequently with European "cholera," a mild epidemic disease causing discomfort not

death, and embarrassment rather than agony. It was probably a paratyphoid infection that troubled them and the symptoms were a source of Rabelaisian humour. It was known as *trousse galant* in sixteenth century France and "ravaged" both that country and England. At times, the epidemics of European "cholera" took a more serious form—they were probably dysentery outbreaks, as in Scotland, where *stowpe galant* was prevalent for a number of years and caused a few deaths. European "cholera" was picayune; Europeans were accustomed to "fluxes" and water-closet humour, but the new cholera from India was shocking. Europe was unprepared for its painfully swift death.

When the tidal wave, born a decade before on the other side of the world, washed over Europe, the people were terrorised beyond the enlightenment of the nineteenth century. Their frenzy was as that of their ancestors of four hundred years before when the dark horseman of plague had raced across the heavens scattering black death over them. There was the same madness, the panic and wild flight from destruction. There was the same agonised unattended death in streets and fields, the same abandonment of humanity as friend shunned friend, husbands deserted wives and mothers fled in terror of their own children.

Asiatic cholera was the most sensational of the exhibits at the great fair of Nizhni Novgorod in 1830, and it dispersed in all directions those of the patrons of the fair who were able to flee. Here, and in many other towns of Russia, doctors, apothecaries, and Jews, and strangers irrespective of religion or profession were accused of poisoning the wells and their lives forfeited to mob violence. In that same year, Russia had invaded Poland and armed with both troops and cholera, had conquered. The defeated Polish army, rather than surrender, retreated across the western border, bringing cholera to Austria and Prussia.

The wave of cholera entering Europe from the east surged westward, reaching Paris on March 19, 1832. There, amid the music and gaiety of a masked ball, the germs disclosed themselves when suddenly a harlequin collapsed, his body writhing, his face bony and grey under his mask. The revels stopped, the revellers halted to stare in consternation and first one, then another and another dropped to the polished floor, contorted in the torment of cholera. Dead and dying were transported to the hospital. All were dead on arrival, and the carriages, turning away, drove on to the graveyard. Into shallow graves, hurriedly dug, the bodies were thrown attired for death in the garments

of Domino, Pierrot and Pierrette, of Columbine and Pantaloon, buried in angel white and Mephisto black. *Swiftly death spread* from masquerade to the reality of the homes and markets of Paris, coffins ran short and corpses were sewn in coarse sacks for their final disposal, hearses crowded the streets and collided with innumerable carriages of the panic-stricken hastening from the cholera-ridden city. The harassed municipal authorities decided that the pestilence came from the refuse that in heaps and mounds littered every street and alley, and gave orders for its removal. Whereupon, to protect their livelihood, the rag-pickers rebelled and blocked the streets with barricades to hinder the garbage-removal wagons. Soon the streets were filled from wall to wall with hearses, carriages and refuse wagons, all immovably and inextricably entangled.

In the midst of chaos, a rumour spread swiftly from mouth to ear. It was not the cholera but secret poisoners who caused the agony and death, whispered the rumourmongers, and their whispers penetrated into every part of the stricken city. Afterward, certain people were selected to be mob-murdered and their corpses were dragged through the streets while throngs of onlookers howled their approval.

Throughout days of terror, in a Paris mad with fear, the germs of cholera continued their work. On some days, only a few hundred died, while on others thousands of twisted shrivelled corpses were grim evidence that the germs from India were indeed more deadly than the germs of familiar European "cholera." The epidemic wave would end as cholera always ended, only when the supply of living human bodies were exhausted.

The comma-shaped germs crossed the English Channel to land on British soil in October, 1831, and introduce the newest disease since the deadly Sweating Sickness of 1485. The new cholera stunned the people of England. Here, as on the continent, there was madness and outrage, and physicians were bitterly accused of spreading cholera for gain. In newspapers and magazines everywhere grotesque caricatures pictured them profiting from the disease they were presumed to have generated.

The first wave of cholera in Europe reached its flood tide, ebbed and vanished in 1838, but before it had receded the germs had reached across the Atlantic. Cholera germs cannot travel by air; sunlight is fatal to them and they do not survive in clean sea water; but men provided ships and human bodies and the wastes of those bodies for their transport. A succession of ships carried the wave of cholera, ships that were to be

notorious for the comma-shaped germs that they carried from the epidemics raging in Europe. The first was the *Constantia* out of Limerick bound for New York carrying 170 Irish emigrants and the germs of cholera. Twenty-nine emigrants never reached the shores of America—their disease-ravaged corpses were thrown overboard into the wide and deep graveyard of the ocean. The ships *Robert* from Cork and *Elizabeth* from Dublin followed, the tragic brig *Carrick*, the pestilential steamship *Voyageur* bound for Montreal, the accused *Henry IV* to New York, and, in later years, the infamous *New York* and *Swanton* with German emigrants and cholera, and the death ships *England* and *Franklin*. They crossed the ocean lanes from east to west, bringing from Europe the pestilence of India to New York, Quebec, Detroit and the Great Lakes. From Chicago the cholera wave flowed southward, and the river steamboat *Constitution* was not alone in bringing cholera to New Orleans, for by then every steamboat on the Mississippi River had become a floating pest-house.

While the crest of cholera flowed downward from the north, a lesser wave followed the ship lanes of the Atlantic Ocean southward to Cuba, flowing on to Mexico, upward to New Orleans and the Mississippi to meet and coalesce with the cholera wave sweeping down from the Great Lakes. The waves that had arisen in India fifteen years before surged together and a new wave reared up that penetrated into the central and western states, and washed over the peaks and passes of the Rocky Mountains to the Pacific. Again on shipboard, cholera travelled across the Pacific to China, to Singapore and back to India—the cholera wave had swept around the world.

When cholera reached New York in 1832, there was panic in the city as five thousand New Yorkers suddenly died of the disease that tortures before it kills. A furious clamour arose among the articulate and outspoken citizens. Among other complaints, they demanded to know why the quarantine records of cholera had been suppressed, a situation which Dr. Peters called "a circumstance which is pregnant with thought." Most of the acrimony was directed at a certain Mr. Fitzgerald, an alien recently arrived from abroad. Fitzgerald had contracted cholera and his accusers objected, not to his misfortune, but to his conviviality. Despite cholera, Mr. Fitzgerald managed to travel to all parts of the city to visit with friends, and he spread the disease among them as well as to his own wife and children at his home on Cherry Street. Furthermore, it was claimed that his parsimony had brought on the cholera. Mr. Fitzgerald had received from his brother in Ireland, where cholera was then prevalent,

a trunkful of soiled clothes, and he had put to use every scrap of rag and tatter. In his own defence, Fitzgerald denied that the clothes had anything to do with cholera. On June 25, 1832, he said, he had spent the day in Brooklyn and had returned in the evening much cheered, but by the next day he was compelled to take to his bed. "Brooklyn," said Mr. Fitzgerald, "is rotten with cholera. I should have remained in Manhattan."

Other citizens of New York had quite different but equally firm convictions on the cause of the epidemic. Dr. Reese, for example, held that cholera was caused by putrefaction of food in the stomach brought on by over-indulgence in spirituous liquors. "Any physician," said Dr. Reese, "who believes that cholera is a contagious disease is unfit to practise medicine and a dunce to boot." Said Dr. Reese, "Cholera is no more contagious than typhus fever, dysentery, childbirth fever or yellow fever—they are not in the least transmitted by contaminated matter as claimed by some fools—all are constitutional symptoms aroused by brandy and other spirits, by ale, beer and wine." For the treatment of cholera, Dr. Reese shunned alcohol, but heartily approved of bloodletting "to unlock the oppressed circulation," and he noted with satisfaction that in cholera victims "on opening the vein, the blood will be found nearly the colour and consistency of tar." He was particularly incensed against those of the medical fraternity who were most popular and whose waiting rooms were always crowded; these physicians treated cholera and most other ailments by bleeding in the customary manner but replaced the blood drawn by its equivalent in brandy, a measure of brandy for each measure of blood.

As the forward advance of the first wave of cholera was rising in America, the cauldron in India spilled over again. The *second* wave of cholera poured over the frontiers, rushed along the ancient land route through Persia, Syria, Arabia, Bokhara and Orenburg, reaching Moscow in less than a year, inundating Europe, surging to its crest in France in 1854 and ebbing slowly for two decades.

Once more the outriding fringes of the cholera wave reached across the ocean to America, and moved to the West. Again the river boats carried it north and south along the Mississippi. The second wave travelled more swiftly than the first of a decade before, since means of travel had improved and there were more humans to harbour and transport the germs. The flow of cholera was quickened also by search for the gold that had been discovered in California, and men rushed from all directions over-

land and by sea to the place where the yellow metal was to be found. The gold-seekers by land reached Sacramento in 1850, the gold-seekers by sea arrived at San Francisco in that same year, and where the two routes met each brought their comma-shaped germs. There was gold in California and there was also cholera.

Living apart from the scramble for gold, indifferent to its glitter, the Platte Indians stolidly watched the mad white men. And when cholera spread to their tribes, the Indians believed that white men in their madness were bent upon exterminating red men, and every night white men were stealthily followed and quietly killed for poisoning the wells of the Platte Indians.

A decade passed in India and a *third* wave bubbled in the cauldron. It overflowed and ran swiftly over the sea to Suez, to Egypt and the Mediterranean, and once again Europe shuddered with fear of the agony and death of cholera. Ten more years elapsed while deadly pestilence destroyed Europeans by hundreds of thousands. Then again the wave departed for America.

To prevent cholera on shipboard, Dr. Woodworth of the U.S. Marine Hospital Service had recommended that "sulphuric acid lemonade should be served out regularly, under the supervision of an officer clothed with authority to see that no one shirks its use." Aboard the transports of the British Army, sulphuric acid mixed with alcoholic spirits was forcibly administered; in India nitric acid was used; and a popular "Austrian specific" contained both sulphuric and nitric acids.

But, despite powerful acids and marine regulations, cholera continued to cross the ocean and to arouse great fear in America. The cholera waves of 1866 in America were mere ripples; a few sickened and fewer died. In India there was less fear, although cholera was always present and death was commonplace; cholera and death had become familiars over the centuries.

The *fourth* wave in India began quietly in 1864 and the Indians scarcely knew that it had begun. It made itself known when the invisible fingers of the cholera wave reached out to pluck at the Indian Moslems on pilgrimage to Mecca, and death swept over them even as they were bowed in worship. And when their bodies contorted in final anguish there was panic and flight among their fellow pilgrims from many countries. The pilgrimage was curtailed, and the pilgrims fled each to his own land to die of cholera and to pass on the comma-shaped germs

as a memento from the sacred places of Islam to the less fortunate who had been unable to make the pilgrimage.

The *fifth* wave of cholera boiled up in India in 1879, receded and hesitated, then, receiving fresh impetus from a great bathing festival on the banks of the Ganges, plunged forward in fury across the borders. It overran Egypt, then continued on its way to eastern Europe, where eight hundred thousand Russians perished miserably. It spattered lightly on western Europe, briefly touched the city of Hamburg and sailed across the Atlantic on emigrant ships to drop sparsely along the shores of North and South America. It was the last wave of the nineteenth century.

In the twentieth century, waves of cholera continue to simmer and boil, contained within the boundaries of modern India. They boil over momentarily to strike nearby Burma, Singapore, the Celebes and China, and occasionally they reach the borders of Turkey, the Balkans and Russia. Cholera in India is no longer a wave, it has become once again a seething whirlpool, churning and swirling as it had done for centuries, before 1817 when it had been moist and humid and the year previous arid and warm and the first cholera wave had overflowed. The germs of cholera swirl and churn in India; half a million died in 1921, one-third million perished in 1924, another one-third million died in 1930, more in 1942, 1946, 1948 . . . The toll is meaningless, the numbers are great beyond comprehension. A single anguished death arouses deep emotion; multiplied a hundred thousandfold, each death is a mere statistic. Life and death is monotonous when life and death is overplentiful.

Once the germs of cholera were free agents, comma-shaped bits of string living in river water, in ponds and streams and in the sea. There some of their descendants, unchanged by cons of time, are still found, hardy and independent, swimming actively for their food, ignoring man and ignored by him. We do not know when the germs of cholera evolved and cholera began, we know only where they evolved—in India. For ages, in many lands, religious rites have required worshippers to bathe together in the sacred waters of sluggish rivers, but only in India are the masses of worshippers so dense and the worship so frequent. They provide endless opportunities for free-living germs to attempt a life of parasitism. This is the way of nature, continuous mutation leading to a new form or a new mode of life or both. Eventually some free-living comma-shaped germs followed the law of nature; they retained their comma-shaped

form but changed their mode of life. They changed from free existence to dependence upon man. In place of the uncertain fare of river water, they revelled in the rich warm interior of the human intestine, and, having adapted and changed and become the germs of cholera, they could not retreat to the river—they must live in the intestine of man or perish.

The germs penetrate into the human intestine and there they grow enormously, prodigiously; no other germs are known to equal the pace at which they multiply their numbers. Sometimes within six hours of their first entrance they have completely filled the intestine, and they rarely require more than three days. They displace other more benign germs of the intestinal contents; the intestine becomes saturated with comma-shaped germs.

An intestine packed with comma-shaped germs is in itself of no great concern, for the healthy human intestine is always filled with enormous numbers of various germ species. The germs of cholera never invade the human bloodstream, never penetrate into the interstices of living human flesh. Described technically and precisely, cholera is neither infection nor disease, is raises no fever, no spots, no sores.

But, a few hours after their entry, many of the germs begin to die, and from each dead germ oozes an irritation. Billions of germs die, each arouses a scrap of irritation, and the irritations accumulate to cause cholera.

The human body is two-thirds water and rich in minerals, both essential to life. The cholera victim soon depletes his body water and minerals and the effect is sudden—he collapses as though struck an invisible blow. His body craves water and minerals, but his stomach rejects them. His skin becomes wrinkled and dry as grey parchment, his nose sharp, pinched and bony; cheekbones protrude, eyes become sunken and glazed, the voice turns feeble and husky; he feels despair and senses the swift approach of death.

Within the body, the loss of fluid has deprived his blood of its mobility. It thickens and flows sluggishly, blood pressure falls, the beat of the heart weaken, painful cramps twist feet and hands, all leading into the final coma. Death often comes within a day, a sudden transformation from life to death, a shrivelled skeleton-like corpse replacing the healthy human body that lived vigorously the day before.

Since cholera is not a true disease, miracle drugs are superfluous. Cholera is merely a lack of water and minerals. When there is no medical treatment, many die; the water they attempt to swallow is violently expelled before it can be absorbed. But

if salt water is injected into the veins, nearly all cholera victims are miraculously certain to survive.

Where the treatment is not known or when there is no one to inject salt water, people die and in dying spread death to others. Once begun, cholera expands with the speed of an explosion. Anything contaminated by cholera—one germ is sufficient—starts the disease anew. The explosive fecundity of the germs is their sole means of survival; they have only a fleeting grasp upon existence as a species. When the ailment of cholera is over, the germs are destroyed, for they cannot live buried in the graveyard. Outside the shelter of the human intestine, they may exist for a few hours in river water, in sewage, on snow and ice, on fruits and vegetables. They cannot live inside other animals, and they rapidly succumb to sunlight, to drying, to competition from other species. Cholera germs live only in the humans whose bodies they inhabit briefly. Someone must be sick with cholera every moment somewhere on earth or cholera will cease to exist.

Europe and America have remained free from the germs of cholera for many years, but in Asia they continue to bubble and boil. It has been suggested that Europe and America owe their freedom indirectly to certain changes of religious practices among the guardians of the sacred places of Islam, to fewer pilgrimages and the consequent shrinking of the flow of cholera along the pilgrim routes. More effective have been rules of hygiene, sanitary engineering, and modern plumbing. Most essential to the restraint of the tide of cholera is our knowledge of the comma-shaped germs that cause it.

CHAPTER III

THE LAW OF THE SOIL WATER

THERE IS no record of the weather over Germany during 1883, nor what the weather had been in 1882 or would be in 1884. At least the records are not available and of little interest now, whether it was dry or humid, whether the rivers had overflowed, or whether the crops had failed.

But the weather, its humidity, was important to Max Joseph von Pettenkofer, chemist, of Munich.

Professor Pettenkofer was noted for his method for the detec-

tion of arsenic, for the analysis of carbon dioxide in air and water, for his test for bile acids. It was Pettenkofer who demonstrated that saliva contains sulphocyanic acid, and his investigations of the mechanism of respiration is still acknowledged as the classic study of this subject. Then Pettenkofer diverged from chemistry to study epidemics among men and to theorise on the causes of cholera.

The sickness of cholera did not lack for theories. There was the *alcohol* theory of Dr. Reese of New York, there were the *water-miasm* theory of Bayer, the *organic-dust* theory of Von Gicltl, the *effluvia* theory of Murchison, the *geological* theory of Lea, the *excrementitious-poison* theory of Dr. Snow. There were Johnson's *blood* theory, Farr's *cholerine* theory and Bryden's *monsoon* theory. There were Sonnerat's theory of *suppressed perspiration* entering the blood, the intricate *fever* theory of Kiehl and the simple *fever* theory of Ilisch, and there was the *ozone* theory to which many adhered but to which no one attached his name. And there were many others. All of these were attacked by Pettenkofer; he ridiculed their postulates, he exposed their absurdities, he listed their contradictions, and he postulated his own absurdly contradictory *Law of the Soil Water*.

No one at that time, or since, understood Pettenkofer's theory, possibly not even Pettenkofer himself. It was complex, it was abstruse, it was statistical and mystical, it was meaningless. No one comprehended it, yet everyone talked and wrote learnedly and profusely on its profound message. To deny its truth was heresy, and there were not many with the naïve courage of Professor Parkes, who wrote plaintively: "Pettenkofer's views are rather difficult to understand; they seem rather wanting in clearness of expression." It was very like the abstract art of today which many detest but to which no one dares object; to inquire is to be abused, to question is to invite epithets, and endless non-sensical words appear regularly in endless columns in every issue of popular art magazines and the art pages of the newspapers, all diligently read by readers who, understanding none of it, fear to admit their ignorance.

Pettenkofer was concerned with the condition of the sub-soil, the sandy or rocky layer beneath the topsoil. He described the pores in between the grains of soil. If there were many pores, water might seep in, and afterward when the water seeped out, it would leave behind pores filled with poison gas. "Damp porous polluted soil exudes a miasmatic poison, confirmed by the disappearance of ozone from the air during a cholera epidemic," and "carbonic acid is given off by the soil in August and

September when cholera is most frequent." (These quotations from Pettenkofer really are as unintelligible as they seem.) If there were no pores in the soil, if the soil was dense and impermeable to water, there could be no cholera. Along the banks of rivers, porous soil was alternately filled and emptied as the river rose and fell, and it was known, said Pettenkofer, that "cholera follows the rivers . . . And," he continued, "people do not contract cholera from each other; they inhale the 'cholera-miasm,' and so they sicken and die. There is no need for quarantine, for cleanliness, to prevent the spread of epidemics—cholera is not contagious," said Pettenkofer.

In most mountainous areas, the soil is rocky and there is little water, yet epidemics of cholera occur in the mountains. "Bosh!" said Pettenkofer. "If the mountain folk would stay in their mountains and refrain from visiting the lowlands, they would not come home poisoned by cholera."

If one lived on soil saturated with cholera-poison, how could one avoid cholera? Pettenkofer would reply scornfully, "What do you do if you live on the side of an active volcano? Or behind dykes hundreds of feet below sea level? You become a fatalist or you move elsewhere!"

What of epidemics of cholera on board ships far out to sea? Many outbreaks took place before and during Pettenkofer's time. Ships at sea have water for drinking and washing, in the bilge, and the salt water on which they float, but they rarely carry soil with or without pores. What of that? Pettenkofer had many explanations for these "impossible" epidemics, and, when confronted with numerous examples, he used his most forceful argument—he denied that they existed!

This was Pettenkofer's Law of the Soil Water, a small part of it—there was more, very much more. No one understood, yet everyone worshipped.

The Law of the Soil Water had become a sacred revelation, and no book of epidemic disease failed to append meticulously a section on soil water and weather at the end of each chapter, usually with a description of the prevailing winds, the present and past history of the climate, and for good measure the volcanic activity. All tried desperately to attach some meaning to the law and to apply it to certain phases of cholera as well as to other epidemic diseases. Baffled, they always ended their discussion by shaking their heads: "This disease is abnormal—it fails to conform to Professor Pettenkofer's beautiful Law of the Soil Water." Every disease, including cholera, failed to conform and no one thought to comment on the unvarying nonconformity. Even today modern science textbooks occasionally mention

Pettenkofer and attempt with difficulty to salvage something from the wreckage of his theory, try to find some small particle of truth in the pretentious Law of the Soil Water.

Any true law in science, however complex, should be capable of presentation in simple words; it is impossible to put the Law of the Soil Water into simple language. To add further to its confusion, the Law was changed repeatedly. As new facts were uncovered, new contradictions and new anomalies arose, and the germs of cholera challenged the law again and again. Pettenkofer had a answer for each challenge—he denied the existence of the germs, he changed his law, he added more patches, until eventually the whole dilapidated unstable structure that he had erected swayed alarmingly in the wind of controversy.

In 1883, Pettenkofer was ennobled for his contributions to man's knowledge of cholera. Also in 1883 there was cholera itself. In Egypt there were deaths by thousands, there were despair and grief. The Egyptian graveyards could not accommodate all of the newly dead, and as fond relatives dragged decaying bodies from alien tombs and reverently replaced them with their own dead there was unseemly violence among the tombstones.

So to Egypt went Dr. Robert Koch to seek for the germs of cholera which Pettenkofer said did not exist. From Egypt Dr. Koch returned, bringing specimens, not of poison gases, not of soils or waters, but of comma-shaped germs. "These germs," said Koch, "cause cholera!"

Pettenkofer was outraged. He demanded of Koch a culture of the alleged cholera germs, allegedly sufficient to kill a thousand men, and Koch sent him several test tubes partly filled with a brownish vile-smelling liquid. The events that followed are somewhat uncertain.

Jordan and Burrows in their *Textbook of Bacteriology* say: "Pettenkofer and Emmerich (his assistant) swallowed a broth culture of 'Koch's vibrio' and developed cholera."

Zinsser in the fifth edition of his *Textbook of Bacteriology* writes: "Pettenkofer and Emmerich purposely drank water containing cholera spirilla. Both observers became seriously ill with typical symptoms of cholera, and one of them (Emmerich?) narrowly escaped death."

Zinsser in the tenth edition states. "Pettenkofer, Emmerich and several of their pupils swallowed broth cultures of Koch's vibrio. Pettenkofer developed only a slight diarrhoea but two of his companions developed a severe enteritis typical of mild cholera."

And, according to Paul de Kruif, "Pettenkofer swallowed the

entire contents of the tube . . . mysteriously, nothing happened . . . an enigma without even the beginning of an explanation."

Other accounts provide additional variations and the precise facts may never be uncovered. The incident has become apocryphal and the details are not too important. Some sympathetic concern is due Emmerich, the faithful assistant of Pettenkofer, for whatever Emmerich may have believed before the "experiment," there can be no doubt about his subsequent opinions. He knew that Koch was right and Pettenkofer wrong, and that he himself continued to live only through the grace of God. He abandoned the soil water theory and joined the pioneers in the new science and went on to make modest contributions to the knowledge of germs.

There are rare men who love truth more than their own work and their own convictions. Pettenkofer was not one of these. He had been regarded as the supreme authority, the first and last word on epidemics and particularly on cholera. He would not renounce his own Law of the Soil Water; he could not allow his Law, the ingenious product of his human reasoning, to be supplanted by senseless germs, insignificantly small comma-shaped germs with no logic, with no theories and no laws, with only the blind urge to exist.

But Pettenkofer was impressed by Koch's "miserable germs in witch's brew." Now that it was proved that the germs did exist, he could not deny them as he had the epidemics of cholera on ships at sea. As the complex unwieldy structure that he had erected swayed and creaked and threatened to collapse, all his many adherents looked to him for guidance.

He did not fail them; he announced his Soil Water Law in newly revised form. In the new law, though he acknowledged that the germs of cholera existed, he rejected their passage from man to man to cause cholera. "Koch is wrong," said Pettenkofer. "There is no contagion in the filth of cholera victims. The germs of cholera, like those of typhoid fever, lose their virulence after they have infected man; they become harmless. The germs must enter into the pores of the sub-soil together with water to ripen and replenish their supply of cholera miasm which had been lost by transfer to the cholera victim whom they had recently inhabited. The soil and its water are still all-important; the germs are secondary, they merely help carry the poison from the soil to the human body." This was Pettenkofer's newest Law of the Soil Water.

If the new theory of Pettenkofer is not clear now, it was no clearer then. It was bulwarked by statistics, and statistics, as everyone knows, do not lie. Pettenkofer devised a complex

method of calculating the numbers of men who would die of cholera according to the water in the subsoil, and they died almost exactly as he had calculated.*

The supporters of Pettenkofer were relieved and enthusiastic. It was true that they failed to understand the new version of the Law, but they had failed no less to understand the original version, and, though they did not understand, they still could write voluminously about the Law—and they did. By acclamation, Professor Pettenkofer was elected president of the Bavarian Academy of Sciences.

Precise and matter-of-fact men like Robert Koch are devastating to vague theorists. His final deflation of Pettenkofer was shocking, approaching the violence of cholera itself. Koch prosaically and mercilessly destroyed the Law of the Soil Water when he recounted his study of the cholera epidemic in Hamburg and Altona. These twin cities of Germany are located on the same bank of the Elbe River, they rest on the same sub-soil, they use the same river water. But the city of Altona filtered its water before pumping through the mains, whereas Hamburg water was used directly from the river. Koch described how in 1892 cholera erupted in Hamburg, not in Altona, how thousands sickened and died in Hamburg, but only a few in Altona—those few who had visited Hamburg and associated with Hamburg citizens and had drunk Hamburg water.

Koch showed cultures of germs that he had taken from the river water, germs of cholera with which Russian immigrants had contaminated the waters of the Elbe. He found the germs in the Hamburg water, but not in the filtered water of the city of Altona, and he concluded: "Man's filth, his sewage, spreads the comma-shaped germs and the germs cause cholera—the sub-soil and its pores are immaterial—there is no cholera miasm."

* Pettenkofer reasoned that at higher elevations there would be less water in the soil and hence less cholera. His calculations led to the following:

<i>Elevation Above</i>	<i>Cholera Deaths per 10,000 Population</i>	
<i>Sea Level</i>	<i>Calculated by Pettenkofer</i>	<i>Actually Died</i>
0	177	174
10	102	99
30	65	35
50	34	34
70	27	27
90	22	22
100	17	20
350	7	6

These results are astounding. How can a theory be wrong and yet appear to be right? Perhaps it was a remarkable coincidence. Perhaps there is another explanation. All the deaths that actually occurred were listed in health reports before Pettenkofer began his calculations and were available to him.

The facts assembled by Koch were incontrovertible and the bizarre structure erected by Pettenkofer finally toppled. His supporters changed allegiance and turned to worship at the shrine of Dr. Robert Koch. The Law of the Soil Water and its author no longer influenced the mainstream of research in epidemic disease. In 1901, four years before Robert Koch received the Nobel award in medicine, Pettenkofer, aged and lonely, ended his life by his own hands.

He had been a good chemist. If he had remained a chemist, he would have lived more happily. He would have died in honour with mourners by his bedside and pallbearers at his funeral procession. But the germs of cholera had changed his life and he died shamefully, violently and alone. Pettenkofer was overthrown not by Koch and the realists of the new science of bacteriology but by the iconoclastic germs of cholera. He was overthrown by germs, even though germs are insensate and their acts are random and dictated by blind nature instead of the intelligence that has replaced instinct among humans. Through the special circumstances created by Professor Pettenkofer, the germs first elevated then reduced him, with neither emotion nor bias. A few years later, other germs were to shatter Robert Koch in the same manner that the germs of cholera had undermined and destroyed Max Joseph von Pettenkofer.

CHAPTER IV

THE WAX-COATED GERMS

MANY MILLIONS of years ago, when the early ancestors of our modern germs were being created, a unique type appeared among the many making their début into the diverse germ population of the earth. These new germs differed only slightly from the others: each individual germ was sheathed with a thin close-fitting membrane of waxy material.

Their early history is of little interest. Despite their waxy membranes, they entered upon a prosaic existence differing not at all from that of many hundreds of other species of germs that lived without distinction. They inhabited the soil in close association with primitive grasses, living freely and independently without obligation to man or any living thing for their sustenance.

Indeed, at that time neither man nor man's ancestors nor any of the modern plants or animals existed. The home of these germs was the soil. Their food was provided by thrifty nature, the decayed remains of primeval plants; it was not lavish but it was adequate. They endured and their species survived, and their line of descent continued through innumerable generations.

The years passed interminably, climates blew hot and cold, land masses rose and fell, seas and oceans expanded and contracted, but the wax-ensheathed germs persisted. Their tiny bodies were almost infinitely adaptable. However drastic or sudden the change of land or sea or weather, only one survivor out of many billions was sufficient to insure the continuity of the species in a newly adapted and more hardy form.

Even after humans appeared, these germs continued to follow their primordial mode of life, harmless to the newly created species of man, independent of his living body, relying upon their own resources for their survival. Today their descendants are widely distributed in the soil wherever there are grassy plains and pasturelands. They are still distinguished by a membrane of wax, and they have become known as timothy-grass germs.

But nature is never satisfied; she continually tampers with her creations. Many thousands of years ago, nature had taken some of the germs of timothy grass and subtly changed them. The change was profound but imperceptible to the coarse senses of man. At the command of nature, these germs left the secure though rigorous life of free existence in the soil to enter upon the uncertainties of parasitism. The waxy coat continued to surround each germ body, but now these hardy and benign germs became helpless and deadly. They were helpless because they could no longer exist in the free life of the fields and pastures; they were deadly because in order to survive they were compelled to invade human bodies. The enigmatic waxy coats acquired a sinister function, and some of the humble germs of timothy grass were turned into the infamous germs of tuberculosis.

Exactly how this came about, we do not know—our science still contains as much mystery as knowledge. We know only that the germs of tuberculosis must have sprung from timothy-grass germs many thousands of years ago. We know that the newly created germs entered into human society, bringing tuberculosis among men.

Tuberculosis is not a solitary disease. The germs seem to avoid isolated farms, they have no power over lonely shepherds and herdsmen, they are repelled by wide clear spaces with clean

air and bright sunshine. The germs are attracted to wherever men live densely together. Tuberculosis is a communal disease, and when the community is ill-housed and ill-fed, the germs thrive best. Tuberculosis is an ailment of civilisation, and the germs follow with the rise and fall of each of man's civilisations, increasing their numbers with each in turn as it expands and becomes great, fading and vanishing with each as it weakens and dies.

Tuberculosis flourished with the Roman Empire and declined as Rome disintegrated, disappearing as towns and cities and villages were swept away in the onrush of barbarians and barbarism. The germs of tuberculosis did not survive among broken walls and blackened timbers. They disappeared from ruins where wildflowers bloomed among potsherds and brick; they died in the newly opened spaces that had become overgrown with grasses and shrubs. For one thousand years the decline continued, the germs of tuberculosis became fewer and fewer and tuberculosis neared extinction.

But a few germs survived, and when the cities reappeared and people once more lived confined within stone walls, the few germs again became many. Civilisation returned, accompanied as always by tuberculosis, and both moved into the European Middle Ages.

Germs of tuberculosis are quite unlike the violent germs of smallpox, black death or cholera. Those dreaded germs rushed into the medieval towns and villages with the speed of a hurricane, carried by the flying horseman of pestilence and scattered by his fleshless fingers from black saddlebags. Those plagues arose suddenly, and everywhere they struck there was terror and pain and relentless death. The plague-infested areas scattered throughout towns and nearby army camps, then spread rapidly to meet and coalesce, saturating the entire countryside with disease. And the doomed, living among the dead and dying, responded with prayer and debauchery, with riot and despair, hastening their own destruction in a holocaust of mass hysteria. When the disintegration of the structure of civilised life was nearly complete, when the germs had harvested all their selected victims, then the plagues departed. The dazed survivors arose from the exhaustion of frenzy and feebly resumed the disrupted rhythm of their daily routine.

Such were the epidemics recognised and feared by the people of the dark ages of Europe.

Tuberculosis, on the other hand, entered the medieval towns on a zephyr, so mild as to be imperceptible. Instead of the dread horseman flying against a darkened sky, a homely traveller rode

slowly into town on a shaggy donkey, a traveller afflicted with a chronic cough, who coughed throughout the night in the common sleeping room of the inn shared with other travellers. Yet the epidemic of tuberculosis did not come from outside to the townspeople; they had created it from within when they left the open fields and the sun and shade of the forests to come to the towns. They crowded within the walls that rigidly confined the city limits, they multiplied in ever denser masses of humanity. They shortened the distance which the breath of tuberculosis must traverse to reach its next victim. The few with disease became many, as the germs of tuberculosis came into the Middle Ages and moved freely among the people.

The germs brought a white plague along narrow and gloomy streets and into grim buildings and dank black cellars where city dwellers lived and worked. It was a gentle plague bringing not terror but sadness and resignation as the signs of the white plague became familiar. Mysterious fevers and night sweatings came and went and returned again, the victims coughed and wiped red spots from their lips, and grew thinner in a wasting away of flesh and blood that stretched the skin tightly over bloodless bones and joints. But it was not a loathsome plague. It created pale ascetic faces, it carved deep hollows below the cheekbones and overlaid them with a hectic flush. It seemed to purify and transfigure its victims; the light of heaven seemed reflected in their large sad eyes.

The common people believed that tuberculosis was a visitation from inscrutable providence, an inheritance of the sins of the parents visited upon them and their children. It must be inherited, for did not many in the same household sicken in the same manner? And were not entire families frequently carried off down to the very last of kin? When the signs appeared, said the people, they were meant as a warning, to prepare one's soul for the ordeal to come, to fast and pray, and to repent and await death.

The medieval physicians agreed with the common people, believing also that tuberculosis was inherited like the colour of eyes or skin. They called the white plague "phthisis" or "consumption." They stroked their beards as they examined their patients and muttered learnedly of slow wasting fevers and predispositions, of weak lungs and hollow chests. Though their ministrations had never been known to alter the course of tuberculosis, they continued to prescribe mysterious potions, to apply poultices and cataplasms, to place leeches and cups and draw blood. They punctured numerous little holes in the skin with their lancets, and sometimes they placed many little cones of

sulphur on the chest and abdomen and set them afire to burn down into the flesh.

As the years passed, the towns became larger and their people more densely crowded. The dark ages changed gradually into the industrial era, and the germs of tuberculosis continued to expand into the twentieth century of human history.

Germs of tuberculosis may readily be seen through a good microscope. They appear as slender bits of string, sometimes curved and occasionally in groups. To this description nothing more can be added for there is nothing more to be seen. All of their deadly potentialities are located invisibly within the germ protoplasm, and around each germ is its membrane of waxy material.

As designed by nature these germs can grow only within the living human body, but science has learned how to culture them in the test tube. Many formulas have been discovered suitable for their culture, each formula identified by the name of the man who worked for years to perfect it. There is Koch's original culture medium. There is also the medium of Roux and Nocard, and the medium that Nocard alone devised. There is Corper's medium, Petroff's medium, Dorsett's medium, Lowenstein's medium. There are the mediums of Theobald Smith, of Pawlowski, of Sander, of Rosenau. There are Petraghini's, Sula's, Kimla's, Poupé's and Vesley's and the mediums of Proskauer-Beck and Dubos-Davis. And there are innumerable modifications of each of these.

In the test tube the germs of tuberculosis grow slowly. They form a thin film of growth after many weeks of incubation, and many more weeks pass before the film thickens into a wrinkled yellowish membrane. And they exude a characteristic odour as they grow in the test tube; these deadly germs exhale a pleasant aroma like that of ripe fresh fruit!

The germs grow even more slowly in the human body, where they invade the lungs and spread throughout tissues and organs.

For protection against infection, the human body has phagocytes to attack and destroy invading germs. The body also has intricate alarms to sound noiselessly when germs intrude, and the alarms arouse the germ-killing antibodies. But the waxy membrane around each of the germs of tuberculosis repels the phagocytes and hides the germs themselves from the body alarms. It is both armour and a cloak of invisibility. And so the germs, unmolested, thrive in the human lungs and spread from living cell to living cell.

Eventually the human body becomes aware of the germs—

the invisibility created by the wax membrane is not quite perfect—but now it is too late; the germs have become entrenched, and active tuberculosis has set in. Frequently tuberculosis sweeps on to rapid death. At other times it drags on, not quite healing, not quite killing, and the victim spends a bedridden lifetime. Sometimes the germs become dormant; the human body encloses each germ within a stony casing and then tuberculosis is considered “cured,” though the entombed germs remain alive and virulent.

It is preferable that the germs not be entirely eliminated but remain alive and inert within the human body. For some mysterious reason, new germs cannot invade and infect the body while the germs of the old infection continue to live. Dormant tuberculosis protects against deadly tuberculosis, and the human body has little resistance unless it has previously had the disease.

When the germs infect a human body that has been untouched by tuberculosis, they grow violently, the germ invasion spreading like a prairie fire in autumn, and the infection ends swiftly in death. From their first contact with the germs of tuberculosis introduced by the white man, Negroes, Polynesians, Eskimos and American Indians sickened and died as though the medieval black plague had come among them. And so it has been for many years. as the civilisation of men spreads around the world, their germs of tuberculosis also spread and are most deadly when they penetrate among primitive peoples who have known neither civilisation nor tuberculosis.

CHAPTER V

THE WAX-COATED GERMS AND DR. ROBERT KOCH

IT WAS in 1882 that Dr. Robert Koch discovered the germs of tuberculosis. He extracted them from diseased bodies, separated them from other germs, learned how to stain them so that they could be easily seen through the microscope and devised a culture nutrient on which they grew in the test tube. He injected the germs from the test tube into guinea pigs and sprayed the air they breathed with a fine mist of virulent germs; then he observed the rapid spread of the disease and made notes of the quick death that followed. It was a brilliant achievement that

rivalled the experiments of Pasteur and equalled his own classical studies on the germs of anthrax and of cholera.

Then his luck ran out. Thereafter whatever he did with the germs of tuberculosis, the germs proved him wrong.

In 1890, Koch discovered a remarkable substance that he had extracted from his test tube cultures of the germs of tuberculosis. He injected it repeatedly into healthy guinea pigs, and it was like injecting pure distilled water—it was entirely harmless. Then he injected some of the same material into tuberculous guinea pigs, and incredibly the tuberculosis infection dissolved into a liquefied mass and fell away. The substance that Koch had extracted from test-tube cultures of the germs of tuberculosis healed tuberculosis in guinea pigs! He called it "Tuberculin."

And then Koch did a strange thing. He refused to describe how his Tuberculin was prepared! He claimed that it required special training and special skills, he argued that it required special materials, he insisted that its manufacture was intricate and dangerous. He gave this reason and that reason—but he would not say how he had made his Tuberculin!

Everywhere in the world, admirers of Koch were shocked and outraged. They wrote indignant letters to medical journals and to Koch, asking if he intended to profit by the illness and suffering of humanity and accusing him of inhumanity and greed. They cried out that he had ceased to be a scientist and a physician and demanded that he be stripped of his rank. His colleagues ostracised him; he no longer received invitations to science meetings and the medical journals rejected his manuscripts.

It was neither humanity nor greed that had motivated Koch; it was patriotism. His Tuberculin had stimulated the imaginations of the practical men of the German Ministry of Health. They envisioned a state monopoly of the cure of tuberculosis and dreamed of Tuberculin distributed all over the world, at a price, labelled "Made in Germany—Exclusively." And Koch's duty to the Kaiser had taken precedence over his freedom as a scientists and over the Hippocratic oath he had sworn many years before.

The world outcry against Koch had its effect. In 1891, Koch described fully the details of his great discovery. And he said, in conclusion, "My Tuberculin will cure tuberculosis wherever it exists. It will both destroy the germs and heal the damaged body. It will both prevent and protect against tuberculosis infection. Soon there will be no more germs of tuberculosis anywhere in the world."

Once again, Koch became the messiah of medical science, and

his lapse of the previous year was forgotten. Once again his name appeared in the medical journals everywhere in the world. His laboratory and hospital in Berlin once again resumed its atmosphere of reverence and awe. He was compared with Hippocrates, with Galen and Rhazes and Jenner, and even with Jesus Christ, who also had healed the sick. In Japan, a temple was dedicated to Dr. Koch where sufferers might come to pray for relief from tuberculosis.

And over all the world tuberculosis sufferers faced towards Berlin and began a pilgrimage. They came by train and by carriage, by boat and litter, and they limped on foot. They coughed and wiped the blood from their lips, dying as they travelled. Struggling to remain alive, they converged on Berlin as on the shrine of a healing saint, to worship and to supplicate for the healing touch of Tuberculin.

Tuberculin became available everywhere in the world. Some of it came from Berlin, prepared under the auspices of Koch. Much of it was made elsewhere according to the instructions of Koch. And everywhere all of it acted in the same way. Physicians everywhere hastened to try the new drug in heavy dosage as recommended by Koch. They injected Tuberculin into their tuberculous patients—and to their consternation, their patients collapsed in agony and died! There were few survivors among the happy pilgrims who had assembled at the shrine of St. Koch; there were few survivors of the Koch Tuberculin treatment anywhere in the world.

The Tuberculin injections were halted abruptly, but not soon enough. There were disturbances in homes and hospitals, in clinics and in offices of physicians. The medical journals that had compared Koch to Hippocrates and Christ now accused him of negligence and recklessness. There were many who called the distinguished Dr. Koch, "Murderer!" There was pandemonium whenever he attempted to lecture at medical colleges. Crowds with sad tearful faces gathered in the street outside his laboratory door, their sadness and tears changing to mad frenzy whenever his door opened, and police were needed to protect him.

Yet it had been a classical experiment, repeatedly endlessly on countless guinea pigs, and all of them had been cured.

But humans are not Koch's guinea pigs. In humans, Tuberculin does not heal tuberculosis; it arouses a violent body reaction with coma, high fever, pain and swift death. And, in the few who do not die immediately, the germs are stimulated to spread throughout the disease-weakened body, and death comes shortly afterwards. Later it also was learned that Tuberculin injected into humans had not the slightest effect upon the

germs, only upon the human tissues in which they become imbedded. Tuberculin suddenly and violently destroys tuberculosis tissue by allergic reaction, and the decomposed material floats into the blood stream to poison, shock, raise fevers and bring death. And if the victim of tuberculosis and Tuberculin should survive, the germs that have been dormant are awakened to spread everywhere in the body.

There soon was not the slightest doubt that Tuberculin, harmless to those free of tuberculosis, was deadly to those infected with it.

It is now known that Tuberculin does not cure but aggravates tuberculosis in guinea pigs exactly as it does in humans. Some scientists believe that Koch had used a harmless strain of tuberculosis germs for his experiments. If so, it was an incredible error, one of the many he was to make in the years to come. Had the practical men of the German Ministry of Health so influenced him that he had forgotten the fundamental principles of scientific research? Or was it merely senility? Shortly afterwards, he divorced his wife to marry an actress. Certainly this could not have been an error, for Dr. Trudeau commented: "You could not blame Koch, but what on earth could this young woman see in him?"

Eventually the disturbances subsided, the weeping ceased and crowds no longer gathered at the door of Koch's laboratory. Throughout the disaster, amid rage and abuse, Koch remained impassive. He was a short round man with thinning grey hair. He would stand erect, his stomach protruding, and stare fixedly through his gold-rimmed eyeglasses at his tormentors. No one knows what he thought, for he said nothing, but continued to work in his laboratory on the problem of tuberculosis.

In 1897, Koch announced an improved form of Tuberculin which he called "Tuberculin R." He described its preparation in full detail. It was made from living germs of tuberculosis that had been crushed and dried into a powder. Said Koch: "Tuberculin R when injected into guinea pigs makes them immune to tuberculosis. Tuberculin R is perfectly safe. When injected into humans, it will not arouse dangerous reactions. Tuberculin R is perfectly safe," Koch repeated.

But the name of Robert Koch no longer bestowed magic powers on the products of his research. Perhaps Tuberculin R was safe, perhaps it was able to cure tuberculosis—we may never know. For the medical profession had learned caution, and they tried the new drug timidly in very small doses and concluded that Tuberculin R had no value. Many physicians refused to try it at all insisting that Koch was not to be trusted

and that virulent living germs of tuberculosis might exist in Tuberculin R. Baumgarten and Walz claimed that they had repeated Koch's experiments and that their guinea pigs, unlike Koch's, were *not* made immune by Tuberculin R. No one since has thought it worthwhile to find out if Koch or if Baumgarten and Walz were right, and in most modern textbooks of bacteriology Koch's Tuberculin R is not mentioned.

In 1901, Koch discovered yet another kind of Tuberculin, which he named "Bacillary-Emulsion." It aroused neither enthusiasm nor criticism. It was just ignored. Today it is not clear whether it was ever tested at all. It was forgotten shortly after Koch had spoken of it, and it also is omitted from modern textbooks of bacteriology.

The misfortunes of Koch did not deter others from entering into the search for the cure of tuberculosis. Petruschky in 1899 wrote that by using Koch's Tuberculin properly he could cure tuberculosis and he gave full details of twenty-two successful cases, but none was able to repeat his successes. Great claims were made for the "Bouillon-Filtré" of Denys, for the "Antiphthisin" and "Tuberculocidin" of Klebs, the "Tuberculos-pasmin" of Buchner and Hahn, for the vaccines of Béreneck, Sahli, Spengler and Spahlinger, for the "Turtle Bacillus Vaccine" of Friedmann and Aronson, and all were found to be equally valueless.

Another group of experimenters looked for a source of immunity in the blood of tuberculous animals. From this research came the famous antituberculosis serum of Viquerat which was first used with the most dazzling successes, successes that became fewer and fewer until no more was heard of the serum. At one time the serum of Maraglio was recommended everywhere by everyone, and afterwards became disowned by everyone everywhere. The serum of Marmorek was introduced as a certain cure and eagerly sought, and soon as eagerly forgotten. There were sera by Tizzoni and by Centanni, by Bernheim and Paquin, by Babes, Mafucci, Di Vesta, McFarland, De Schweinitz, Fisch, Patterson—they came in loudly and left inconspicuously. In all there were fifty of them with grandiose claims that could not be confirmed, their names written along the walls of a long gallery of great hopes and bitter failures. They tell a tale of human science and of scientists eager to do battle with tuberculosis but who retired discomfited by the germs, which cling tenaciously to their wax-coated existence.

Of all these sera and vaccines, today there survives only Koch's Tuberculin in its original version and in a purer form known as the PPD (Purified Protein Derivative) of Siebert. They

are not used to cure tuberculosis but are injected cautiously and only in the merest traces to diagnose tuberculosis.

Scientist Robert Koch continued to study tuberculosis, and the wax-coated germs continued to humiliate him. When he had discovered the germs in 1882, he had observed them in both diseased humans and cattle. Though tuberculosis in humans differs from tuberculosis in cattle, Koch believed that the germs were the same. The disease differed because the flesh of men and of cattle differed, said Koch, but there was only *one* species of the germs of tuberculosis. In Europe no one openly dared to disagree with him, but in the new world a great American bacteriologist did disagree. Dr. Theobald Smith had studied tuberculosis in cattle and in humans, and in 1896 he described and named *two* species, the "human" and the "bovine" species of germs of tuberculosis. Then, after more research on both sides of the Atlantic, the results were published in English and German. Finally, after five years of scientific wrangling, Koch acknowledged his error. Grudgingly, he admitted that there were indeed two kinds, the human and the bovine species of the germs of tuberculosis.

The occasion on which Koch admitted that he was wrong and Smith right was the meeting of the International Congress for Tuberculosis in London in 1901. He admitted that the germs of bovine tuberculosis existed. "But they can infect only cattle," said Koch. "They are unable to infect men; they are of no importance"—and he began another controversy. Many bacteriologists at the congress submitted research papers describing severe tuberculosis among humans caused by the bovine species of germs and demonstrating numerous cases of tuberculosis caused by contaminated milk. They defied Koch!

A year passed. The next meeting of the International Congress for Tuberculosis was held in Berlin, and again Koch spoke on bovine tuberculosis. He presented no experimental work of his own, but weighing and analysing the work of others he proved his points by inference and argument, again *denying* that bovine tuberculosis could infect humans.

The opposition to Koch did not subside. The dispute smouldered, flaring up again and again. It was a vital question; thousands of human lives were involved, thousands of humans would live or die and their life or death would depend directly upon the conclusions drawn from this controversy. Should tuberculosis among cattle be ignored (as according to Koch), or should it be regarded seriously and as a part of human tuberculosis (as according to his opponents)?

In 1907 the Royal Commission on Tuberculosis of Great

Britain investigated human and bovine tuberculosis and decided that Koch was wrong. But, when the next International Congress for Tuberculosis met in Washington, Koch refused to accept the decision of the Royal Commission. The controversy became bitter and harsh words and furious voices were used to support scientific evidence. Through the babel the calm voice of Koch persisted, as he pointed out errors in the evidence presented, listed contrary evidence and drew up rules by which this kind of research should be governed. His theoretical arguments and logical reasoning refuted the facts of clinical and laboratory evidence, and when the Congress for Tuberculosis had adjourned, Koch had converted most of the delegates to his view.

The germs of tuberculosis had confounded completely the brilliant mind of Robert Koch. Everything he had said was reasonable and scientific, but his arguments lacked the vital ingredient of *truth*. In 1910, Park and Krumwiede completed a careful study of tuberculosis that proved that *one third* of all tuberculosis among children is caused by the *bovine* germs of tuberculosis.

We are not certain that Dr. Koch read the reports of Park and Krumwiede, for he died shortly after they were published. We hope that he did not die in confusion and arrogance. If he did read the research reports, he may have thought of many things. Perhaps he thought of the children who had died of bovine tuberculosis over the past decade; perhaps he tried to estimate their numbers, these children who owed their deaths to Dr. Koch. Or perhaps he thought of Professor Pettenkofer, who also had been wrong and who had died so disgracefully nine years before.

Now, there is no moral to this tale of germs and Robert Koch, for germs are blind and senseless. There is no moral to be found in anything that they do. Perhaps there is an element of luck in research work that is usually underestimated. Koch may have been lucky when he discovered the germs of tuberculosis and unlucky when he tried to halt the wax-coated germs and to cure their pestilence. Somehow the brilliant mind of Koch had been dimmed and warped when confronted by the formidable germs of tuberculosis.

Today the germs continue to frustrate the efforts of our finest scientists and most advanced research.

There was Dr. Edward Trudeau who in 1873 bade farewell to his friends and went to the Adirondack Mountains to die, but instead at Saranac he found life. He founded Trudeau

Sanatorium so that others doomed by tuberculosis might also find life, and many came, many were healed, yet many died among the green trees and the rocky crags of the mountains, and neither Dr. Trudeau nor anyone since knows exactly why some continued to live and some died. Eventually, as the years passed, it was realised that pine-scented air and clear mountain vistas were good places in which to live or die, but they are not miraculous healing agents. Only rest can heal tuberculosis, rest and nature. The infected wounds of the lungs will improve only if the lung is quiet; then nature and the body defences may heal the wound and encase the deadly germs within stony walls. Only complete rest and nature are important. The peaceful mountains are pleasant, but they have no magic healing powers.

Early in the twentieth century, a remarkable experiment was planned. It was momentous, it was ambitious—it proposed to protect all the peoples of the world against tuberculosis!

Two French scientists planned the experiment, Dr. Albert Calmette and Dr. C. Guérin. As planned, it was neither a brilliant nor an exciting experiment, nor one that would have crucial and dramatic moments. As a matter of fact, it promised only tedious work and anxious days. All it required in the beginning was patience; later it would need a strong mind and a stubborn will. Many years would be required to complete the entire experiment, more years than are found in a normal lifetime. Dr. Calmette and Dr. Guérin could not hope for recognition of their work or expect scientific honours. They knew they could not live long enough to see the final results of their experiment. If it succeeded, they would never know it.

Why waste a lifetime on a dull research problem whose results will never be seen by the researchers unless they see it from the other world? Why do it when the rewards, the scientific honours and the acclamations, if any, will all be posthumous?

We can imagine that Dr. Calmette and Dr. Guérin may have put these questions to each other. We do not know the answers they gave, but we do know that they did go on with the experiment. They were not brash and ignorant youths. They were mature men in their thirties, experienced bacteriologists and members of the Pasteur Institute. Perhaps these two men shrugged their shoulders in a fine Gallic manner, smiling self-consciously or even mockingly; they may have bowed deeply to each other and uttered silly words such as "*C'est la guerre*—the fortunes of war against the germs. . . ." And then they most probably said, "Now let's see what we have to do. . . ."

So the two scientists, Calmette and Guérin, began the experiment that was to continue after they had gone—they took

some germs of tuberculosis and transplanted them to a test tube containing a bit of boiled potato, some glycerine and a small amount of ox bile. The potato and the glycerine are nutrients on which germs thrive, but the ox bile is mildly poisonous to them and the transplanted germs grew scantily and slowly. A few weeks later, Calmette and Guérin transplanted these germs to another test tube containing potato, glycerine and ox bile. A few weeks later, they again transplanted the germs. Every few weeks they repeated the transplant—230 times over thirteen years! Now the first phase of the experiment was completed.

For the second phase, Calmette and Guérin injected these germs into guinea pigs, monkeys and cattle. And they found that the ox bile had weakened their germs. The injected animals did not develop tuberculosis, but, more important, they became immune to the disease! The animals could now resist massive doses of the most deadly germs of tuberculosis! The germ culture that the two scientists had nurtured for thirteen years had become a special strain of germs called BCG, the “Bacillus of Calmette and Guérin!”

However, Calmette and Guérin did not begin to inject BCG into humans. They repeated the injections of animals, repeated them again and again, wanting to be certain that BCG was completely safe before trying it on people. They would inject a batch of guinea pigs with BCG, then inspect them after a week, after a month, after six months. Eventually they dissected each guinea pig, looking for signs of tuberculosis in every tissue and organ, and they did the same with other kinds of animals. They repeated their experiments for ten monotonous years. Finally they were certain that BCG was not only harmless but also unchangeable; it would never revert to a dangerous form. Most important of all, it never failed to immunise animals against tuberculosis. The second phase of the experiment was now complete!

It was time for the third and final phase.

First Calmette and Guérin vaccinated themselves with BCG, then they vaccinated their associates, called for volunteers and vaccinated them. Neither the scientists, their associates nor their volunteers suffered the slightest ill effect from the BCG vaccinations. In 1922, Calmette and Guérin proceeded to vaccinate children. First by feeding BCG rolled into pills, later by injection, they cautiously vaccinated a few children, then more and more until many thousands had been vaccinated. Now came the most difficult part of the experiment for Drs. Calmette and Guérin, for there was nothing more to do except wait and pray

that none of the children would develop virulent tuberculosis from the BCG.

Tuberculosis is a slow-moving disease. Only when working on animals can scientists speed up their experiment by injecting heavy doses of virulent tuberculosis germs to test the animals immunity. For human experiments, they can only wait and compare the children as they grow up, those who were BCG vaccinated against those who were not, and count how many contract and die of tuberculosis in each group.

It was terribly slow and tedious research. There were many difficulties and many anxieties, requiring even more patience and the strongest convictions. There was for example the disaster that shocked Lübeck. In that German city, two hundred babies had been vaccinated by German physicians with BCG, and soon afterward they coughed until blood ran from their mouths, and one after another they died of virulent tuberculosis!

"The BCG did it. It is not safe. The germs revert to the deadly kind!" shouted some physicians. "It is carelessness. Someone was negligent!" said others. "It is a plot meant to discredit France and her scientists," or "It is an unfortunate coincidence," said still others. And, amid recriminations and tears and a confusion of words and actions, the BCG vaccinations were hurriedly stopped. A committee was appointed to investigate, and the men on the committee studied and probed and questioned and examined and cross-examined. They deliberated behind locked doors, while years passed and BCG remained in cotton-stoppered test tubes, unused.

At last the doors were opened and the committee filed out— anxious moments for Dr. Calmette and Dr. Guérin—and the verdict was announced. There had been an accidental substitution, reported the committee. A BCG culture had in error been replaced by another culture, and the Lübeck babies had been vaccinated not with BCG but with a deadly strain of the germs of tuberculosis. It was regrettable, the people responsible would be punished, there would be suitable compensation in marks and pfennigs to replace the dead babies, said the committee. But BCG is completely absolved. BCG is completely harmless, they added, and the vaccinations must proceed.

The great experiment did proceed. It moved ahead more slowly and cautiously now because of the Lübeck disaster, but it moved ahead.

Suddenly there was another setback, and the BCG vaccinations were again halted. A group of scientists claimed they had isolated deadly strains from among the benign germs of BCG. But other scientists were unable to confirm their results. There

were many discussions and much argument and lengthy articles appeared in every issue of the medical journals. And still other scientists entered the debate and said they had doubted the value of BCG all along. They hinted at fraud in the benefits claimed and insisted that at best BCG could help only primitive peoples. Not one of the embattled scientists would admit any possibility of error in his work or argument, and they chattered and haggled like pushcart peddlers. The scientific wrangling that had begun with a roar gradually faded into a muttering and finally into a rustling like dry dead leaves. The controversy over the alleged deadly strains in BCG remains today unresolved. There was no official verdict, but it was tacitly agreed that BCG was safe and the great experiment continued.

It continues today. The sceptics have become increasingly silent, for the benefits have accumulated. Now it is acknowledged that in humans, as in animals, vaccination with BCG causes increased resistance against deadly tuberculosis.

We are witnessing the last phase of the experiment that began over fifty years ago. As these words are being written, Dr. Guérin, but unfortunately not Dr. Calmette, is still here to witness it with us. Dr. Guérin cannot hope to see the end of his great experiment—few of his generation will be alive when it reaches complete fulfilment. Instead he sees with a rare gratification how the *Bacillus* of Calmette and Guérin has spread around the world and penetrated benignly into every land where people live—the very same germ culture that Calmette and he had first transplanted fifty years before into a test tube containing glycerine, potato and ox bile.

We are now in the midst of a great campaign being waged by man against the germs of tuberculosis that have plagued humanity for so many centuries. Quietly and efficiently, the peoples of the world are being immunised against the disease. Aided by the World Health Organisation, millions of children everywhere are being vaccinated with BCG. If the experiment is successful, then ten to twenty years from this date, millions of these children will be living as adults instead of resting in obscure small graves all over the world. Everywhere there is hope that the great experiment of Calmette and Guérin will succeed, that where the synthetic drugs of the chemists have failed, the germs themselves in the form of BCG will succeed. Somehow it is more fitting that the problem raised by the formidable germs of tuberculosis be solved by the power of their own protoplasm, and that the germs of tuberculosis be checked not by the miracles of man's chemistry but by the miracle of nature's biology.

A decade ago enthusiastic physicians at the Mayo Clinic and the Cornell Medical Centre spoke of streptomycin, a drug without equal, a drug they said would kill the germs of tuberculosis and make the disease extinct throughout the world. But the germs of tuberculosis with their waxy membranes are ages old, and have survived many attempts aimed at their destruction. They slipped through the miracle net of streptomycin. They became resistant, even using streptomycin for food, and they continued to spread tuberculosis among men as they had for all the years before streptomycin was discovered.

Strangely, when tuberculosis is most deadly, the miracle drugs become most helpful. In the past, when malignant tuberculosis had begun and the germs had spread rampant in deadly seeds throughout every tissue and organ of the human body, the victims died. Today, when streptomycin is used, half of them may live. The brain invasion of tuberculosis meningitis was invariably fatal before the era of miracle drugs; now one out of five cases is saved by streptomycin. But streptomycin and the entire gamut of miracle drugs cannot heal the brain injury of tuberculosis meningitis; they cannot remove the paralysis or subdue the tremors in arms and legs, or restore intelligence to minds made defective by the wax-coated germs.

However, when pulmonary tuberculosis becomes severe and and drugs fail, when death waits impatiently, then the modern physicians place their patients entirely into the healing hands of nature. They use crude sacrifices to placate and ensure her aid. They collapse the diseased lung to enforce its complete rest by injecting compressed air into the chest cavity, cutting the nerves that stimulate breathing or hacking at the ribs in a rough and bloody operation. They do this when one lung is critically infected. If both lungs are diseased, no miracle drugs are needed, only miracles.

The names of miracle drugs that claim to heal tuberculosis are loudly celebrated today. They emerge from the laboratories one after another accompanied by jubilant fanfare. When they fail to sustain the claims shouted by their sponsors, they are easily forgotten, except by those to whom the failure is a bitter and tragic disappointment. After streptomycin, there was Neomycin to heal tuberculosis, but Neomycin turned out to be inferior to streptomycin. There are Promin and Promizole, Diasone and Tibione and Sulphetrone; there are Isoniazid and Para-Amino-Salicylic Acid, there are Terramycin, Dihydrostreptomycin, Mycomycin, Aureomycin, Viomycin and a host of others. They claim to be swords against tuberculosis, but their blades are dull. And recently the unhappy ghost of Koch was aroused, his Tuber-

culin has been revived and once again it is being tested against the germs.

CHAPTER SIX

THE UNCLEAN GERMS

AND CRUEL inscrutable mother nature took certain members of the harmless wax-coated germs of timothy grass and made changes within their protoplasm. A new species of wax-coated germs were created. Though they looked exactly like the germs of tuberculosis, they differed in some incomprehensibly intricate manner. From nature's experimental laboratory, the germs of leprosy emerged to test their newly created mode of life, to intrude upon the community of human beings.

This experiment of nature may have been done several thousand years ago somewhere in Asia. Indeed the germs may have been created in that very region of northern India at the river Indus where the Garden of Eden is said to have bloomed and where it is believed the first man evolved from the lower animals.

From the focus of their creation, wherever it may have been, the germs migrated. Nature's touch had destroyed their independence; they were no longer free-living but were now obligate parasites needing the bodies of men for their survival.

They migrated slowly to the east, and ancient manuscripts of silk and paper written in Chinese and Japanese characters tell of the loathsome disease that the germs brought to the people of those early times.

They migrated slowly to the south, and the description of the leper was inscribed in Sanskrit in the chronicles of old India.

The germs may have migrated to the north but there is no evidence of it. There are no records of history in the bleak lands of Siberia and perhaps the people there were far too thinly dispersed to carry and pass on the germs.

Slowly the germs migrated to the west. They moved along the caravan routes through Persia, crossed the rivers Tigris and Euphrates, passed through mysterious Chaldea and sinful Babylon, travelled over the sands of the Syrian desert, over the

Jordan through Canaan and the Wilderness of Shur into the Land of Goshen in ancient Egypt. And the signs of leprosy became a part of the Old Testament, and lepers were described in Egyptian papyri written five thousand year or more before the birth of Christ.

They reached Constantinople at the gateway to Europe, and very slowly they crossed the threshold and trickled into the continent. They arrived in Greece during the era of Aristotle but their progress into central Europe was infinitesimally slow. Then Pompey's army returned to Rome and with his soldiers the germs began to move more rapidly. Later, when the returning Crusaders travelled over all of Europe, the germs moved in greater numbers. They leaped from Africa across the pillars of Hercules into Spain and Portugal, saturated Europe and crossed the channel to England. Farther north the leprous tide moved up the fjords of Sweden and Norway into Iceland, the Baltic countries and Finland and over the vast expanse of Russia. They crossed the oceans to the new world; they reached Australia and the many islands of the South Pacific.

When the germs of leprosy were created, nature defined severely their mode of life. When they invade a human body, they infect the skin and the superficial nerves, rarely attacking other tissues or organs. The germs are masked by waxy membranes and are overlooked by the defences of the body. So through the skin or along the nerves the germs grow, advancing so slowly that many years pass before the first signs of leprosy appear.

A thickening of the flesh at the bridge of the nose is the first sign. Then the lobes of the ears enlarge. Leprous tubercles appear on the face and body as pale pink, red, violet or brown spots, or as a silvery sheen on the skin, or like a breaking out into "small red potatoes." The eyebrows are destroyed and the face becomes puffy with heavy ridges on cheek and forehead. The "leonine" face of leprosy gradually emerges.

Usually the infection goes no further. But sometimes it advances rapidly to attack the throat and cause the raucous "leper voice" or to produce "leper blindness" by clouding the cornea of the eye. Sometimes the "lepra reaction" follows, with high fevers lasting for weeks, destruction of flesh and bone, bleeding and always excruciating pain. After the "lepra reaction" has ended, the leper remains motionless for weeks, weakened and exhausted and close to death, consoled when he is told he is "improved," or dismayed when he learns that his condition remains unchanged or has "deteriorated." And medical science

cannot explain why at times the infection is mild and at other times deadly.

When the germs invade the nerves, leprosy begins with white patches everywhere over the body. Later some infected areas of the skin sweat profusely while the normal surrounding skin remains dry. Imperceptibly the next stage emerges—loss of sensation in the fingers, toes, nose and ears. The leper has now lost the feeling of pain which nature has devised as the spur to our self-preservation. He may walk through fire and be unaware that his flesh is burning, or wash in boiling water and not notice that his scalded skin shrivels and falls away. Fingers may disappear, the entire hand becomes a shapeless stub, and the nose, ears and feet eventually be lost. At other times, nerve leprosy may do no more than cause a slight contraction of the little finger. In rare cases, nerve leprosy may flare up into sudden paralysis and death, and medical science has no explanation.

The germs of leprosy expanded, and leprosy spread over Europe. It was like a repulsive fungus growth creeping over the land, bringing horror as it reached into every town and village. There were learned men in Europe, but none of them dared to study the disease. It was loathsome, and those who would have attempted to associate with it would have been regarded as no less loathsome than the lepers themselves. Among the common people everywhere, lepers were the accursed of God, being punished for sins too horrible to be named. As soon as they were discovered, the lepers were driven away, to live by begging and exist as best they could away from the society of non-leprous humans.

Leprosy reached its height in Europe in the thirteenth century and then began to decline, and with its decline the study of leprosy slowly emerged. It began formally in the nineteenth century, a strange science peopled with strange personalities and filled with reckless experiments that were remarkably illogical and self-contradictory and with theories that could not be proved.

It is possible for a man to wish he had leprosy? Dr. Daniel Danielssen was such a man.

In 1840, he had begun to study leprosy as it existed in Norway among his countrymen. For many years he had observed and studied, and it seemed to him that leprosy must be a contagious disease. He noted how one leper would enter and live in a leprosy-free community, and how after a few years the signs of leprosy would invariably appear among the other members of the community.

Danielssen attacked the problem directly and heroically. He snipped a bit of infected skin from a leper, cut a slit in his own skin and inserted the leprous material into his own flesh. Then he waited several months, but no signs of leprosy appeared. He repeated the experiment. He inoculated himself innumerable times; he inoculated his associates at the leper hospital, his assistants, his students, the nurses and volunteers from among the townspeople. He used bits of leprous skin from old advanced cases, and tried skin from newly infected lepers in whom the first signs of the disease had barely appeared. For weeks and months afterwards, he and his associates examined their bodies, looking eagerly for signs of leprosy, and were disappointed when none were found.

Years passed while Danielssen continued to inoculate leprous material into healthy human bodies. Towards the end, he lost interest and worked mechanically. For none of the inoculations ever developed into leprosy or any disease even vaguely resembling leprosy! Today there is still no satisfactory explanation of the results of Danielssen's experiment.

Reluctantly, Danielssen was convinced by the weight of the accumulated results of his experiments. "Leprosy is a disease of metabolism," he said to Hansen, his assistant. "It is not contagious, it is an inherited ailment, a metabolic disorder that is passed on from parent to child and thus perpetuated." And now Danielssen was satisfied, or perhaps he was tired and discouraged. He was finished with experiments on leprosy.

Some of Danielssen's colleagues accepted his conclusions, but others refused to believe them. They repeated the leprosy inoculations. No one knows how many thousands were inoculated; none of them became leprous. Keanu, a Hawaiian criminal, had been condemned to death, but he volunteered for leprosy experiments and his execution was stayed. He was inoculated with leprous material. Shortly afterwards, there was much excitement among the scientists, for leprous tubercles broke out all over Keanu's body—it was a case of virulent leprosy. Then it was discovered that Keanu had associated with lepers for most of his life; his entire family were lepers. So the excitement subsided, the experiment was discarded, and Danielssen's conclusions remained unchanged. Keanu benefited little from the worthless experiment. It is true that he escaped the gallows, but he died soon after from virulent leprosy.

Recently, some experts have declared that these experiments were based on error and should never have been done. Only the very young are susceptible to leprosy, say these experts. But when

Bargigli injected leprosy matter into young children, no leprosy resulted.*

There was another school of scientists who connected leprosy with diet. Some of them believed that eating the flesh of sea-gulls caused leprosy; others were inclined to blame spoiled rice or corn, or the excessive eating of roast pork. Most prominent among this group of scientists was Dr. Jonathan Hutchinson—he believed that leprosy was caused by eating fish.

Dr. Jonathan Hutchinson was a famous personality of the mid-nineteenth century. He was an eminent physician and acknowledged everywhere as a great authority on syphilis. It was Dr. Hutchinson who first studied the peculiar facial expression afterwards known as “Hutchinson’s Squint.” He found that syphilis causes a salmon-coloured spot in the eye and it has since been known as “Hutchinson’s Patch.” There is an ailment that leads to a staring eye; it is “Hutchinson’s Pupil.” He noted certain kinds of itching and his colleagues named them “Hutchinson’s Itch.” “Hutchinson’s Triad” denotes the symptoms of hereditary syphilis. “Hutchinson’s Teeth” refer to the notched, peg-shaped incisors characteristic of congenital syphilis.

He was brilliant, versatile, more than a physician and specialist; he lectured frequently on the poetry of England and he was particularly fond of the works of Wordsworth. He was knighted by Queen Victoria for his many accomplishments. But Dr. Hutchinson believed that leprosy was caused by eating fish!

He abandoned his work in medicine, syphilis and poetry, gave up his lectures on English literature and entered upon a crusade to prove that eating fish caused leprosy. It was a crusade that continued for the remainder of his life. He travelled to all parts of the world, searching, questioning, asking everywhere about fish-eaters and nonfish-eaters. He visited the peoples who lived on islands and along the seacoast; he went among river-bank dwellers and those who lived on the shores of lakes. He looked for fish in their diet and for leprosy on their bodies. He climbed up high mountain peaks and down into deep valleys, went deep into the interior of continents, shivered and froze in the regions of the far north, and in the dense jungles of the tropics he swatted at insects and cursed and mopped the sweat from his great bald head.

He was overjoyed when he found leprosy among the fish-eating people of the South Pacific islands. He was downcast

* Bargigli believed that he would have succeeded if he had been able to procure more children for his experiments. (“*Je ne pus que deux fois seulement(!) l’autorisation de pratiquer cette opération.*”)

when he also found leprosy flourishing among the mountain people of the Tibetan border, people who lived on grain and milk and the meat of domestic animals and who had no word for fish in their language because they had never seen a fish. He found leprosy deep in the interior of darkest Africa. He found no leprosy among certain islands near New Guinea and off the coast of Borneo, although the natives of these islands knew no food other than fish.

The most stubborn of men would have given up, but Dr. Hutchinson was unshaken. He pulled at his beard. (The men of medicine in those days always sported a beard. It was a tradition; it gave them an air of importance and professional dignity. When stroked slowly, it enhanced their reputation for wisdom and knowledge of the medical art, it was useful for wiping dirty fingers and it served admirably to hide their dismay whenever their patients died suddenly, as they frequently did. Hutchinson used his to reaffirm his self-confidence and strengthen his faith.) He pulled fiercely at his great black beard and he continued his search.

Many years passed and Hutchinson was still collecting data, making notes, inquiring and interviewing, reading old documents and health reports, examining for leprosy and accumulating thousands of pages of information. And always it seemed to him that the proof he needed just barely eluded him, that it hid in the next bend of the road he travelled, that he would find it in the next far-off land he visited.

The years continued to pass and the era of Pasteur and Koch arrived. In Norway, Dr. Armauer Hansen, the faithful assistant of Danielssen, inspired by the discoveries among the germs of disease, looked for and found the germs of leprosy in 1874. (How he married Danielssen's daughter, how he refused to be intimidated by his father-in-law's monumental research, how he discovered the germs of leprosy and was almost cheated out of the credit for his discovery—these are parts of another chronicle and may be told another time.)

There was no doubt now. Everyone agreed that leprosy was a contagious disease caused by germs just like all the other contagious diseases—everyone except Hutchinson. He continued his crusade, but the time at his disposal was running out. On his deathbed in 1913, he solemnly asserted his belief for all posterity to hear. "Leprosy is caused by eating fish; there is no other cause. Hansen's germs are artifacts, bits of skin tissue that have been coagulated and stained by Hansen to resemble germs. Mark my words," gasped Dr. Hutchinson with his dying breath, "when fish-eating ceases, leprosy will dwindle and disappear."

Many other crusaders have followed in the wake of Hutchinson. They lack his fire and indefatigability and none of them devotes a lifetime to the crusade, but they also propound theories that have no proof and are easily contradicted.

Some of them say, "The germs of leprosy cannot flourish in the temperate or arctic zone. Only in the tropics does leprosy survive." Somehow they overlook the epidemic in Norway and Sweden that began a thousand years ago, that increased despite the strictest quarantine and isolation and that has only recently disappeared. They forgot that the leprosy epidemic in Iceland has existed for seven hundred years and has not yet quite ended. They do not recall that in the seventeenth century one French family brought leprosy to New Brunswick, and the germs thrived in the chilly climate and spread over all of Nova Scotia; and that many years later, when the Acadians were banished from Canada and exiled to Louisiana, they brought with them the germs of leprosy.

Others insist that excessive moisture is needed for the propagation of the germs and cite the extremely humid climate along the West River in Canton Province where leprosy is prevalent. Someone then points out that the province of Shantung is the most leprosy-infested region of China, yet its climate is remarkably dry! And someone else lists the various lands where leprosy is to be found and concludes, "Leprosy is still present in all parts of the world, at high or low altitudes, in the cold, temperate or torrid zones, on seacoast or inland."

Then an eminent authority publishes a report describing numerous cases of leprosy infection among doctors, nurses and missionaries who have worked among lepers. Immediately another equally eminent authority sternly denies that the doctors, nurses and missionaries who take care of lepers ever contract leprosy. Whom are we to believe?

Some say that smallpox vaccinations increase the spread of leprosy, while others maintain that it causes leprosy to disappear. Some say that leprosy and tuberculosis are antagonistic, that the one disease drives out the other, and then someone else points out that most of the natives of French Guiana have both leprosy and tuberculosis.

Most authorities agree that it is very difficult to become infected with leprosy; they say it takes long and intimate contact with a leper before the disease is transferred. But what of the European men who visited the islands of the South Pacific who are known to have acquired leprosy after a single appointment with a leprous prostitute? And what of the lone Chinese leper who came to New Caledonia in 1853 and lived with a native

woman, and who started an epidemic of leprosy that swept over the island and spread rapidly to the entire island group?

What happened in the case of the two American sailors who were tattooed in Australia? The tattooer was a leper and, a few months after, leprosy developed and spread from the tattoo marks!

And what of Dr. Socrates Lagoudaky? He was a Danielssen kind of man who in 1936 injected leprosy germs into his veins. But he was more fortunate than Danielssen—within a short time, the signs sprouted all over his body. Lagoudaky had developed a fine case of leprosy!

If it is so difficult to acquire leprosy, then how can the strange story of Nauru be explained? Here was an island in the South Pacific, a small island paradise known also as Pleasant Island, and it was free from leprosy. Lepers were forbidden to enter Nauru, but a leprous woman did enter in 1912 by special permission of the German governor general. She died two years later. No other lepers came to Nauru, but the seeds of leprosy had been planted and slowly they germinated. In 1920 there were four lepers on the island, the next year there was 60, the following year there were 242, in 1924 there were 365! Is leprosy then so difficult to transfer? There are many other questions about the epidemic of leprosy on Nauru, but they probably never will be answered. The Japanese army invaded the island during World War II and, although they were uninterested in theories of leprosy epidemics, they ended the leprosy on Nauru most efficiently—they took all the Nauru lepers far out to sea, weighted them with chains and tossed them overboard. Since then there has been no leprosy on Nauru.

Many hundreds of years ago, so it is told, in the great city of Benares in Burma there ruled the wise and beloved King Rama. But one day misfortune descended and the happy people of Benares mourned, for King Rama and his queen had become lepers. Now this was the law of the land and it had been so from time immemorial: lepers may not remain, they must at once leave the city of Benares. Even great kings and queens must obey the law. So it was that King Rama and his queen put aside their sceptres and removed their crowns, discarded their royal garments and wrapped their bodies in the coarse yellow robe of the leper, and they walked slowly out of Benares while their people wept uncontrollably. All day long they wandered over the fields, passing by towns and villages. They begged for their food and drink and they slept under the sky. They made their way into the wild Burmese jungle, followed the animal trails be-

tween the trees, walked aimlessly around rivers and lakes and struggled through dense underbrush. Suddenly they came to a clearing and in the clearing was a holy shrine. As they stopped and worshipped at the shrine, their weariness overwhelmed them, and they slept on the ground under the spreading boughs of a great kalaw tree. Then, in a dream, a shining vision emerged from the kalaw tree and appeared before King Rama. It said not a word, but it pointed first to the king's leprous sores and then to the fruit of the kalaw tree. Three times the shining vision did this and then smiled benignly and disappeared back into the tree. When King Rama awoke, he remembered his dream. He picked fruit from the kalaw tree and he ate, and gave fruit to his queen and she ate. And suddenly the loathsome scales fell away from their skin and they became free of leprosy! Rejoicing in their now healthy clean bodies, they returned in triumph to Benares.

Such was the legend of King Rama. Many centuries later, when modern scientists studied the kalaw tree, they found that the yellow-brown seeds of the miraculous fruit contains chaulmoogra oil. A short time later, excitement and enthusiasm erupted in certain medical circles, for chaulmoogra oil suddenly became the latest, most modern miracle drug for leprosy. The germs of leprosy were doomed to extinction, said these medical circles!

Lepers are accustomed to drugs that are expected to do miracles; they had been subjected to a long series of miracles long before the rediscovery of King Rama's remedy.

At one time it had been the coal-tar dyes that promised to cure leprosy miraculously. In the middle of the nineteenth century the first of the dyes was discovered, and for many years as fast as the chemists synthesised them they were injected into the bodies of lepers. The lepers turned blue or red or green or violet as each dye circulated through the blood stream. Then they sickened and died, not of leprosy—their leprosy was unchanged by the coal tar dyes—but the dyes were toxic and destroyed their kidneys, and the lepers died of acute nephritis!

Then the bottles of dyes were returned to the laboratory shelf to gather dust, for "protein therapy" had replaced them in the favour of scientists and physicians. Now they injected foreign proteins into the veins and the lepers either collapsed in agony or died of anaphylactic shock.

Next some scientists and physicians injected cobra venom; others injected typhoid or paratyphoid vaccines, or antimony or arsenic. And those lepers who did not die of the injection lived on with their leprosy undiminished.

A favoured drug was potassium iodide. It had no effect on non-lepers but when injected into lepers it caused them to scream with pain and fall into the most horrible convulsions. Potassium iodide never cured any leprosy but it remained a favourite with many physicians who prescribed it again and again.

They tried sulphonamide drugs. They used heavy doses of Promin repeatedly and recommended it highly for the treatment and cure of leprosy even though no case of leprosy had ever been known to improve by its use.

They tried to kill the germs by heat; they put the lepers into hot boxes and kept them there for hours or until they died of heat stroke. And the germs of leprosy were stimulated by the heat; among the lepers who survived, their disease became worse.

They gave the lepers chaulmoogra oil.

They gave the oil by mouth. The lepers swallowed and then became dizzy, choked and gagged and vomited, and the blood vessels burst in their stomachs as they continued to vomit hours after there was nothing more to throw up. So the physicians mixed the oil with milk and carbonated water and persuaded the lepers to try it again. The lepers did; they coughed until they turned blue, became nauseated and were ill for several days. Then the physicians administered the oil in pills and capsules, sprayed it into the throat, injected it into the muscle of the thigh or into the skin or directly into a vein. And sometimes the leper fell into a raging fever and writhed in agony and moaned piteously, and sometimes he collapsed at once into merciful unconsciousness.

To many lepers undergoing the chaulmoogra oil therapy, suddenly their cure seemed unimportant; they preferred the leprosy to its treatment. Then it became necessary to dose forcibly, or withhold food until they agreed to be reasonable. Some lepers went hungry for many days before reluctantly submitting to chaulmoogra oil, and sometimes a leper in a locked room faced with starvation or chaulmoogra oil escaped from both alternatives by taking his own life.

Eventually the scientists and physicians recognised that chaulmoogra oil is a dangerous drug that kills more easily than it cures. So they added opium to the oil to deaden the pain; they added benzocaine and atropine, camphor and resorcin. They concentrated on methods of giving chaulmoogra oil painlessly and harmlessly. They concentrated so hard that they failed to notice that, no matter how the oil was given, it still failed to heal leprosy.

Was King Rama mistaken? Was his story a fable that never

happened? Had chaulmoogra oil cured any cases of leprosy, any cases at all, even one lone case of leprosy? Was chaulmoogra oil a stupid and terrible hoax? Dr. George McCoy of the U.S. Public Health Service wrote in 1942, "Chaulmoogra oil and its derivatives are of little or no curative value and the unpleasant side effects probably outweigh any advantage to the patient that might possibly accrue from their use."

The germs of leprosy and the germs of tuberculosis are almost identical in appearance, and they cause diseases that are similar bacteriologically and medically—but sociologically they are at extremes. In the Victorian era, the tuberculous patients were considered interesting. They displayed an ivory pale skin, coughed dramatically, spoke languidly, charmed with their weakness and intrigued with their spells of illness and fever. They lost weight delicately and became emaciated and died in a refined manner. These symptoms were the inspiration for Minnie of *La Bohème*, for Antonia in the *Tales of Hoffmann*, and for many other ill-fated heroines who were required to die emotionally but genteelly. Even the ghastly symptoms of tuberculosis of the larynx—the husky voice, the severe pain, the regurgitation of food—served Thomas Mann for dramatic interest and realism in the major character of *The Magic Mountain*.

Similar symptoms are observed in lepers, but the effect is quite different. Their skin pallor is rotting tissue, their cough a loathsome croak, their weakness a tottering and disgusting palsy, their emaciation a gruesome decay, their periodic illness a nauseating morbidity and their death a profound relief.

The germs of tuberculosis received distinction from association with Virgil, Keats, Shelley and Walt Whitman, with Elizabeth Barrett, Molière, Goethe, the Brontë sisters and Robert Louis Stevenson, with Mozart and Chopin, Raphael, the Hunchback of Notre Dame and Punch of Punch and Judy. Tuberculosis turned Giovanni Bernardone from a life of debauchery and converted him into St. Francis of Assisi.

The germs of leprosy brought a horrible death to Robert Bruce. They are known in connection with the leper in *The Vision of Sir Launfal*, with the seven leprous daughters of Pharaoh Valid who were healed by the infant Moses, with Miriam who became leprous because she took offence when Moses took an Ethiopian woman to wife, with the leper Emperor Constantine who could be healed only by bathing in the blood of three thousand children, with Naaman the Syrian healed of leprosy by Elisha, with King Abgar of Edessa healed of leprosy by Jesus, with Iphigenia from whom leprosy was taken by St.

Matthew and transferred to the heathen king who sought to abduct her.

In the Dark Ages, those "accused" of leprosy were judged in a court of law, and if they were found "guilty" they were condemned as though to death. The convicted leper was compelled to wear a shroud, he was mourned by his family and his friends, his will was read and his estate distributed according to its terms. He was led in solemn procession through the town and out of the city walls to the lazarus house. There the priest intoned the requiem mass and guided the "dead" man to the leper cemetery. A grave was opened and from it three handfuls of earth were taken and thrown upon him. Then all departed except the leper. He remained behind, and after a bitter pause he walked slowly toward his fellow lepers, or perhaps he stood silently, numbed by dreary thoughts, while they came to him. They removed his shroud, and he donned the yellow robe they offered, took up a leper's bell, the pail and the cup. And he entered upon a leper's existence, tolling his bell to warn of his unclean presence, extending his pail and cup for food and drink. He could beg, but he must beg in a whisper, and he dared not touch those whom he supplicated. He was forbidden to converse with anyone except lepers like himself. He might look upon his wife, his children, his friends and kinsman, but must forever keep his distance.

Such was the charity of the Dark Ages, and, though it seems meagre today, charity it truly was. For then the lepers were called "Christ's Poor," and sometimes they were given food and sometimes they were ignored, but they were allowed to live in peace. In other times, when disasters fell upon the brutish people of the dark towns and villages, lepers were the first victims of terror and rage and frustration. Then they were called "accursed!" and hunted down and slaughtered like vermin. In 1313, Philip the Fair had decreed that all the lepers of France be gathered together and burned alive in one gigantic bonfire. The edict was never enforced for it had been decreed at a time when the lepers were "Christ's Poor," and the lepers were allowed to enter the monasteries of St. Lazarus. These refugees became known as lazarus houses. At the height of the leprosy epidemic in Europe, there were nearly two thousand lazarus houses into which the lepers were herded, to live by begging if they could, to be exterminated by pestilence or mass butchery by their fellow humans or to die simply from the lack of will to live.

Centuries passed, the Dark Ages became an incredible era far

back in the past, human society became more humane, and science and education replaced superstition and ignorance. But the germs of leprosy continued to flourish in Central and South America, in most of Africa, in Spain and Portugal, in the Near East, in the Far East from China to Singapore, in Australia and in many islands of the South Pacific. And everywhere the lepers remain outcasts as they have always been.

In 1846, an Englishman arrived in India to become the newly appointed magistrate of a district. What he saw and heard horrified him, and he sternly commanded the people of his district, "Thou shalt not burn thy widows, kill thy daughters or bury alive thy lepers!"

In 1937, all of the lepers in a Chinese town were invited to an Easter breakfast, and, once assembled, they were shot down like rabbits and their corpses tumbled into a deep pit and covered with lime. In another part of China, it was customary to ply lepers with rice wine until they were stupefied, and then they were sewn into cowhides and thrown into the river. By another custom, a feast for lepers was provided in a wooden storehouse, and as the hungry lepers ate, the doors were sealed and the building kindled and as it burned additional wood was piled on until nothing remained but grey ashes. In another part of China, no specific means of extermination was suggested, but a bounty of five dollars was offered for every leper killed by any method.

During the nineteenth century, leprosy came to the United States from Norway and Sweden, and for many years the germs persisted in Minnesota, Iowa and Wisconsin. There is always leprosy in California; the germs are repeatedly reintroduced with the Mexicans, Hawaiians, Filipinos and Chinese, coming from lands where the pestilential seeds of leprosy are always germinating. There is still leprosy along the American gulf coast, brought many years ago by the people of Evangeline.

In the United States, modern times have not changed the social stigma of leprosy. The courts of America protect and sustain the stigma. Federal law protects a non-leprous American citizen from being called a leper—it is libellous and penalties are provided to compensate for ruination of character and economic status. When modern lepers are discovered, they are taken to the National Leprosarium in Carville, Louisiana. There is no court trial and no burial ceremony; the hospital diagnosis is sufficient. Instead there is a modern ritual: a court hearing and a penal bond of five thousand dollars. Sometimes, when a highly infectious patient escapes from Carville, a nationwide alarm is broadcast to the police of every state. It is rumoured that, despite

every precaution, many patients have been known to "go through the fence." Most of them are caught and returned to Carville. A few find that there is no freedom for lepers outside the gates of Carville and return voluntarily. A very few who escape are never heard from again.

The modern miracle drugs have not worked miracles on the germs of leprosy, nor have they failed. With the sulphone and streptomycin drugs, with much patient effort, with trials and errors, many cases of leprosy have been improved.

In the opinion of medical experts, a leper ceases to be a leper when he is non-contagious and shows no signs of leprosy. Modern human society ignores the judgment of medical science and believes: once a leper, forever a leper. When the ex-leper is discharged from Carville, his ordeal is not ended. He finds that he cannot leave behind his uncleanness. He will never be allowed to forget his misfortune. He may live in a temporary haven by changing his identity and burrowing in among the dense population of a large city. But at any moment a chance recognition or an unwise word may expose him, and then he must resume his flight from society. Though he shows no sign of the unclean disease, he remains a pariah, possessed forever by the germs of leprosy.

CHAPTER VII

THE RELUCTANT GERMS

MANY AILMENTS are said to plague man, but there is only one true plague, the bubonic plague. It has also been known as the Black Death or Black Destroyer, as Death Incarnate or as the Sword of God, but it is best known simply as "The Plague." It is "The Plague" that conjures up images of medieval walled towns, with locked doors, torchlights and burning homes, of terror and flight, of hooded figures on death carts rattling over cobblestones and shapeless forms lying motionless in the deserted streets. The centuries have paled the horrors, but through the writings of contemporaries we are able to understand dimly the debasement of dwellers in those ages, the wretchedness of their lives and, when bubonic plague unfolded its black robe of pestilence over them, the misery of their deaths.

Bubonic plague was one greater outrage among many lesser outrages to humanity in the *Dark Ages*.

But bubonic plague is primarily a disease of rats, a problem for rats to consider—man has so many other germs which are distinctly his own. The germs of plague were designed by mother nature to prey only upon rats. When they invade man, it is an error that nature probably never planned. The people of the *Dark Ages* died in multitudes from a disease of rats.

Under normal conditions, the germs of plague remain dormant within the bodies of the rats. When conditions become abnormal—and our science does not know what those abnormal conditions are—the germs explode into a raging epidemic and thousands of rats sicken and die of plague like human beings.

Rats have fleas. The fleas leave the bodies of dead rats when they grow cold and seek new warm living rats, and as they migrate they carry with them the germs of plague. When fresh rats are not to be found, the fleas bite men, and then the germs, in their desperate compulsion to survive, reluctantly invade human bodies. The fleas themselves are unwilling carriers of the germs and like rats and men suffer severely from plague. Many of them die and the survivors cannot rid themselves of the germs. For mankind, it is bitter humiliation—to die horribly, bitten by reluctant fleas, infected by reluctant germs.

Wherever there are men there are rats, and wherever there are rats there may be bubonic plague. The Roman Empire was destroyed less by the crude weapons wielded by barbarians than by germs of plague. Over the centuries, plague struck again and again until Rome disintegrated. In the year A.D. 68 plague erupted and ten thousand Romans died each day. Plague returned in A.D. 79 and again in 125, but when it next came to Rome in 164 it remained for sixteen years, exterminating half the civilian population and nearly all the Roman army. Before this assault, even the great physician Galen fled.

When early in the fourth century Constantine transferred the seat of government to Byzantium, the Roman Empire failed to elude the germs of plague. For in Egypt plague was scurrying on deadly rats' feet northward up the valley of the Nile towards Asia Minor. It reached Constantinople in the middle of the sixth century and there it tarried. On some of the many days of its stay, ten thousand would die from dawn to dawn in evidence that not Justinian but plague ruled the new capital of the Roman Empire. Leaving ruin behind, plague returned to Greece, marched forward into Italy, where it killed half of the inhabitants of the former centre of Roman power and then continued

on to continental Europe and Britain. In the sixth century Celt and Saxon struggled with each other and with plague.

After fifteen years of march, plague reached the Rhine, where the armies of germs advancing with rats' feet came to a halt and began to recede along the route by which they had advanced. As they retreated, they eventually re-entered Constantinople and with virulence undiminished by travel again fell upon that wretched city, extinguishing the last vestiges of Greco-Roman civilisation. Now the dead of Constantinople could not even be buried, for there were not enough grave-diggers and graveyards. Corpses were piled anywhere that had space to receive them—in walls, caves, pits, pools, lakes and rivers. The roofs of the warning towers on the city walls were removed, the towers crammed with bodies and the roofs replaced. There was no need for warning towers—no human armies would knowingly advance on Constantinople. Many years passed before the stench of decaying human flesh disappeared from the air.

For eight centuries there was a lull—Europe, Africa and Asia were free of plague. But as the centuries passed, unknown to the men of Europe, Africa and Asia, their destiny was being shaped in a distant and desolate land. Tensions had been rising in the region of the Gobi Desert, tensions in the natural balance of nature, which after eight hundred years reached the breaking point. In the Gobi desert the rat population had increased far beyond the bounds set by nature for their survival. There were too many rats; they must disperse their numbers or starve. So they began to migrate, and as they migrated the germs of plague dormant within them awoke and fed ravenously on an abundance of furry bodies. First the pent-up plague-ridden rats exploded into the adjoining lands spreading rats and plague far and wide over the continent of Asia, to the east, south and west. Then they overflowed to the sea and into ships; and in the Near East, in Asia Minor and far-off Africa, rats and men died of plague. Once again they crowded into unhappy Constantinople, the gateway through which the hordes of plague have always poured into Europe.

From the Gobi Desert, rats and germs also spread to the east—to China. Of the plague there, Hecker writes: "Nature is not satisfied with the ordinary alternations of life and death, and the Destroying Angel waves over man and beast his flaming sword." Plague spread the darkness of death over the land, but not before, according to Hecker, a stupendous series of unnatural events, "the like of which has not previously ever been seen or written by human man." The plague broke out in 1347

but the preliminary catastrophes began fourteen years before and continued uninterrupted until plague itself arrived as an almost welcome relief. Before the plague, parching drought and stony famine gripped the land, to be followed by torrents of rain that poured down in a continuous flood for days and weeks, during which four hundred thousand Chinese drowned miserably. The mountain Tsincheou "fell in" with a crash that resounded for hundreds of miles and deafened millions of ears. Then there was a lull, and during the lull the first faint sign of plague advanced, a thin breath of that which was to follow. It came and it withdrew—five million died. Shortly afterwards an earthquake near Kinsai shook the ground and the tremors levelled the land as far as one could see. More mountains "fell in" and great lakes formed where they had been. Again there was famine and four million more perished. Deluges raged once again, locusts swarmed everywhere to continue the destruction of life that had survived the other holocausts and then famine returned anew. An earthquake struck, with shocks uninterrupted for six days. Mountains continued to "fall in," deluges continued to pour from the heavens, earthquakes to shake the land, while locusts in inexhaustible numbers returned with monotonous regularity. Finally plague came and spread over the exhausted land and thirteen million Chinese who had survived the preliminary catastrophes died of plague.

Of the plague in Cyprus, Hecker relates that there were earthquakes and hurricanes, the sea overflowed and ships were dashed to pieces and, most horribly, "the wine in the casks became turbid and unfit for drinking." Then followed "a pestilential wind that blew so poisonous an air of miasma that many fell down, their breath diffused a pestiferous odour, and they expired in dreadful agonies. The fertile and blooming island became a desert and a thick stinking mist advanced from the East to overlay all Italy."

Rats and germs swept from the Gobi south to India, and "mahamurree" depopulated that populous land.

Rats and germs poured from Gobi west, and neither their high mountains nor the freezing weather shielded the people of Kurdistan from the Black Death. At an elevation of five thousand feet, and in midwinter, the germs invaded the villages of the Kurds, and because in midwinter at that elevation each village is isolated by snow and ice the people could not flee. When the spring thaws opened the roads to travellers, they found villages without life, every home occupied only by its dead.

Plague overran the Caucasus and the land was dotted with unburied corpses.

Plague moved back into Europe after an absence of eight hundred years. In 1347 plague-infested rats disembarked from the ships of returning Crusaders and on the land they expanded prolifically, reproducing and dying in endless cycles and waves. As the rats died, their fleas migrated and with them went the germs of plague. Then the people began to die, first singly and then in droves like the rats. Plague spots would appear on the victims and soon their blackened bodies would fall lifeless, to encumber the homes, churches, market places and fields. During one year of plague, one hundred thousand died in Florence and an equal number in Venice, and of the million pilgrims that had converged on Rome for the celebration of Holy Year scarcely one tenth returned to their homes. In that year, twenty-five millions, a fourth of the population of Europe, died in one "Great Mortality."

Many people fled from their plague-infested homes and swarmed into Lübeck, where miraculously no plague had come. Suddenly plague erupted in the crowded city. And so horrible were the cries of the sick and dying that, according to Hecker, "the people in despair destroyed themselves as if in frenzy rather than fall victim to the plague."

The epidemic at Avignon exterminated nine tenths of the population, and the River Rhone was consecrated by Papal decree so that its waters could be used as a burial ground. Not all died of plague; terror and avarice joined with the disease to destroy the Jews of medieval Europe. When the terror reached its height, the rabble of Avignon fell upon the cripples and beggars. They called them the "accursed of God," slaughtered all who could not flee and drove the others into the deserted fields to die of starvation. When the plague still continued unchecked, the rabble turned against the nobility, but these powerful antagonists within their massive castles were impregnable against man, if not against the germs of plague. The nobility, heavily indebted to Jewish moneylenders, incited the mob; the Jews, they claimed, had polluted the wells, the food, the very air, to spread the poison of plague. The mob needed little urging and the slaughter began. The unfortunate Jews that escaped simple butchery lived only to regret their respite—they lived to be tortured until they "confessed," and to be burned alive.

In Basle all Jews were locked into a wooden building which

was set afire and burned to the ground. At Strasbourg two thousand Jews were burned alive on their own burial ground, and at Mayence twelve thousand Jews perished in a gigantic bonfire. And the same frenzy possessed the people wherever there was plague in Europe.

Some Jews forestalled the mobs by locking themselves in their homes and setting it ablaze themselves. Others under torture accepted baptism and were spared a fiery grave, but only for the moment, for as the plague continued to rage the madness reached new heights; the newly baptised Christians were accused of spreading plague nevertheless, their crime having been committed previously while they were Jews, and they were dragged out to die by fire.

Once begun, the slaughter soon went beyond control. In some towns where no Jews resided, the gravediggers were accused of spreading plague and suffered the fate of the Jews elsewhere. In many places where all Jews had been destroyed, Christians were singled out for suspicious acts, accused of spreading plague and condemned to torture and death. Such was the insanity of fear of the plague that to intercede for those accused meant mob death for the interceder. As long as the plague persisted, the carnage continued and the merciful edicts of Pope Clement VI and the compassionate commands of Emperor Charles IV fell on deafened ears of howling madmen all over the length and breadth of Europe.

Apart from the continent of Europe, the people of England saw the pestilence approach and in great terror beseeched the aid of divine providence to stem the onrush. But their prayers were to no avail; plague crossed the Channel and England suffered as did the rest of Europe. One-hundred-thousand perished in London and many more thousands died throughout the British Isles.

From England plague went by ship to Bergen, Norway, and there disposed of one third of the population. It is said that many ships that put out to sea failed to reach any port, for plague erupted on board, and, with dead men for crew, the ships sailed aimlessly until they foundered.

All of Scandinavia suffered from rats and plague; Iceland and Greenland found no protection in their frigid climate. The vigorous and cultured people who inhabited Greenland declined after plague reduced their numbers and destroyed the spirit of civilisation that had been flourishing there.

Bubonic plague reached its maximum height in the years 1348 and 1349, then subsided and disintegrated into a continuing series of small sporadic outbursts. It is believed that plague

ended when the fierce grey rats from the north entered Europe and drove out the black rats. The grey rats, unlike the black rats, spurned the intimate habitation of man and instead infested wharfs, barns, sewers, granaries and warehouses, and, although they also suffered from plague, their diseased fleas were not so readily accommodated with substitute human habitat.

Certainly plague was not diminished by medical treatment—the medieval physicians knew only the art of bloodletting. Blood flowed copiously during the epidemic and sufferers died all the faster, the physician himself frequently becoming infected and dropping beside the lifeless body of his patient.

Throughout the sixteenth and seventeenth centuries, minor epidemics broke out frequently in Europe. In 1557, the germs erupted in Holland. "A sudden and terrible plague broke out between Delft and The Hague in a small village, and spread over the whole county before the rising of the Dog Star. This plague was presaged by stars and fire falling to the ground in the streets of Delft. Children on their play dugged graves and carried dead coffins on their shoulders; sung funeral hymns like their priests, and pretended to bury living children, their play-fellows." (Dr. Thomas Short, *A General Chronological History of the Air, Weather, Seasons, Meteors, &c.*, London, 1749.)

A greater outbreak arose in London in the year following the comet of 1664, but it was far from becoming a "Great Mortality." The plague ended abruptly when the Great Fire of London burned down the homes of men and their rats, and seventy thousand human victims and an untold number of rodents died. Afterwards, England was free from epidemics of plague until 1907, when a small short-lived outburst followed soon after well-nourished rats had been observed dying in the fields. In France a final epidemic had devastated Marseilles in 1720. Then the plague left Europe and has since not returned.

Halfway around the world in India the history of plague began anew. There, as in Europe, plague had raged over the centuries, gnawing at an inexhaustible supply of human bodies. Then for two hundred years there had been a lull; plague existed only as small insignificant epidemics. Suddenly, at the end of the nineteenth century, it erupted in Bombay. There were rats in India, both brown and black, there were fleas and the dormant germs of plague. Strangely, the plague that descended on Bombay did not arise from the Indian plague that had alternately smouldered and blazed in India over many centuries; the Bombay plague came from rats, fleas and germs originating thousands of miles to the northeast. For, from the Gobi Desert where plague smoulders eternally, rats and fleas and

germs had arrived at Hong Kong in 1893 and from Hong Kong had moved on to Bombay.

From Hong Kong across Burma in a direct line to Bombay are three thousand miles of land across high mountains, deep valleys and wide rivers. The Hong Kong rats took the circuitous sea route, longer in miles, shorter in time for short legs, travelling aboard ship for three years around Singapore through the Malaya Straits and across the Bay of Bengal to Bombay. Chinese and Indian rats rubbed noses and brushed whiskers and exchanged greetings, fleas and germs. In 1896 the brown and black rats of Bombay crept out of their holes from the fields, houses, wharfs, warehouses and granaries, lured on by the Pied Piper of plague. They crawled uncertainly and feebly into the open fields and streets, became torpid and immovable. They died, thousands and millions of them, and from their cold bodies fled millions upon billions of fleas carrying infinite numbers of the germs of plague. Two weeks passed and human plague broke out in ever-mounting destruction, hundreds dying that year, thousands the next, the epidemic continuing year after year. In 1904 and again in 1905 the toll was one million dead; in 1907, one and one-third million died. The plague has since ebbed and has killed not more than a half million in any one year.

As rats and men died in India, scientists from all over the world gathered to study the disease. They could not heal the dying or keep pestilence from those untouched any more than they could return to life the dead that lay everywhere. They could only study—count the numbers that sickened and record how many died per day per flea per square inch or rat per square foot of ground. Many multicoloured charts were drawn and tabulations compiled, all complete with curves of normal distribution, standard deviations, probable errors and coefficients or correlation. They wrangled with each other and fretted over the contrariness of humans who failed to live or die according to the predictions of their charts. They followed a major upheaval—the brown rat was discovered to harbour twice as many fleas as the black rat! Back to their laboratories scurried the harried scientists, hastening to adjust that distressing dislocation of the statistical curve of death analysis. Tons of valuable data were discarded and replaced with others containing the flea correction. And now, as people died, their deaths fitted beautifully on smooth curves of normal distribution on the graph paper, each dot a hundred thousand lives. There was plenty of material for graphs and tabulations—ten million died between 1896 and 1918!

Another problem arose with the Manchurian epidemic of 1910. There were few rats in that bleak region where fur trappers plied their trade, but plague saw fit to visit. It was argued convincingly that many years ago the tarbagan or Siberian marmot had replaced the rat as agent for plague. This was in accord with the belief of the Manchurians that tarbagans were once men who had been changed into animals by the gods because of their boastfulness, and, it was said, being man-related, if a tarbagan became ill, his illness became transmitted to his nearby human brothers. Other authorities argued without benefit of Manchurian folklore that plague was transferred from man to man on droplets of virulence-laden sputum from diseased lungs. They pointed out that during the winter, when plague raged most fiercely, the Manchurians huddled in closed steamy huts, ideal conditions for the perpetuation of the disease. It is not certain which of these explanations is correct nor how plague arrived initially. It is only certain that in Manchuria from 1910 to 1912, in a sparsely populated land, sixty thousand Manchurians sickened of plague and sixty thousand died.

CHAPTER VIII

THE SLEEPING DEATH IN THE SYLVAN GLADES

RATS AND fleas are the unwilling tools of plague. The prime villains themselves are the germs of plague, *Pasteurella pestis*, named grotesquely and appropriately in honour of the greatest of bacteriologists and the deadliest of pestilences.

Germs of plague are helpless when separated from flea and rat and man, yet in human fluids outside the human body they can survive for weeks. In the infected blood drawn from a victim they remain alive for months, and within a human body dead of plague and buried for over a year living virulent germs may still be found. A plague germ culture, grown and sealed into a test tube, was once mislaid and forgotten for twenty-five years and, when opened, it contained living and deadly germs of plague. The germs die of dehydration upon exposure to fresh dry air, but when the air is moist and humid, as in a small Man-

churian hut without windows and crowded with occupants, they live for days.

They frequently lose their virulence, but the taste of fresh blood restores it manyfold. They are incapable of motion, depending upon air currents or fleas or rats or the flow of human blood for transport; yet they possess a unique quality known to bacteriologists as "invasiveness." They can cause internal disease by mere surface contact, invading by penetrating through the intact healthy human skin—an incredible feat among germs. No less than humans, the humble rat flea is confounded by *Pasteurella pestis*. Despite its small size, the flea's stomach has powerful digestive juices; these are the only germs which resist digestion in the flea stomach, which can thrive and multiply there to suffocate their flea host.

But the germs are harmless to man as long as the infected rats remain alive and the fleas remain on the rats, harmless in the sense that bombs attached to warplanes are harmless while still attached, or torpedoes inside submarines are harmless as long as they remain inside. In the plague areas of the world there are many rats that harbour plague germs without being plagued. The germs they carry are dormant. Then suddenly the germs acquire virulence in some mysterious life cycle, the epidemic flares and thousands of rats crawl out into the open to die. The hungry fleas that have abandoned the dying rats can hop, not very high, but high enough to bite the human foot or ankle. Having taken a tentative bite and probably been repelled by the strange flavour, they hop off to try elsewhere.

But the germs have been transferred; the tiny jaws of the tiny flea have penetrated and left some germs behind, and a human has received an invisibly small inoculation with virulent plague germs. It is enough. And the curtain rises on an episode of plague.

The grim drama begins slowly, rises rapidly to a climax and ends abruptly. For nearly a week nothing happens. The germs are quietly reproducing, overflowing into the lymph channels and riding the gentle lymphatic flow to the lymph glands of the upper thigh and groin. There for a time they are held back from further expansion, and they accumulate and continue their growth. The lymph glands restrain the germs from a general invasion, but the restraint is only temporary. Soon the lymph glands become painful, swell into inflamed agonising lumps, then into festering abscesses which become the dreaded buboes that are the insignia of bubonic plague. Within a few hours the corrosive germ toxins have completely destroyed the lymph glands and the germs are free to migrate everywhere, to the spleen,

the lungs, the brain, the skin. Wherever they lodge there is hæmorrhage as the blood vessels are eaten away and the blood oozes out into the tissue spaces. The skin of the plagued body becomes covered with dark spots of hæmorrhage.

Abruptly the victim feels the effects; one moment he enjoys good health, the next he alternately chatters with cold and burns with fever. He staggers like a drunkard and falls exhausted, his body overcome by the torment within. His face assumes the grimace of pestilence—the drooping eyelids and stupor, the fixed countenance of extreme anxiety and wild fear and of resignation to death. The heart flutters rapidly and weakly, trying in vain to circulate blood through the disintegrated blood vessels into the suffocating tissues of the body. The tongue, covered with a shiny white fur, swells until it completely fills the mouth, the skin turns black with stagnant blood . . . and the rigour of death sets in.

And so an episode of bubonic plague begins and ends. It has the quality of unreality, of a nightmare far away in time and space, and we in our modern era, ten thousand miles from Bombay where plague smoulders fitfully, six hundred years past the “Great Mortality” of the Middle Ages, we complacently eye our well-stocked pharmacies, our shiny hospitals, our trained bacteriologists and nurses and physicians. Plague seems very remote.

When plague consumed the people of medieval times, no rational treatment was known. There were only charlatanism and superstition, and plague raged unchecked until it burned itself out. When plague explodes in India, there are too many patients, too few hospitals, insufficient nurses and physicians. Our modern centres of civilisation possess a formidable armament against disease: penicillin, streptomycin and a long and growing roster of newer antibiotic drugs. We have at our disposal sulphonamides of a hundred different varieties; we have plague vaccines and antitoxins. Would not these be more than adequate to subdue the germ of plague if an epidemic should arise?

They would not!

Penicillin has no effect whatsoever on these germs. Streptomycin and the newer antibiotics slow their growth but do not destroy them. Antitoxins have proven to be of no value and vaccination has given no protection. Treatments of any kind must be available promptly. With a day's delay, the best of treatments becomes remedies of desperation. When the germs are held back in the lymph glands (bubonic plague), the delaying action provides some small protection, giving time for the

body defences to rally, and one out of ten victims may survive. With modern medical treatment it has been claimed that survival chances are somewhat improved, that a few victims survive that might otherwise succumb but that others succumb as though untreated. When the germs lodge in the lungs (pneumonic plague), the mortality has been 100 per cent in the past, and the percentage is changed only infinitesimally when all the resources of modern medicine are available. A few cases among many have survived when streptomycin and sulphonamide drugs were used in combination, and the medical reports have hailed the survivals as miracles. But, when the germs invade the brain to cause plague meningitis, then, in our enlightened era no less than in the Middle Ages of six hundred years ago, drugs and physicians, modern or medieval, serve only as futile attendants at the death bed.

Plague reached the United States fifty years ago! Over the first half of this century germs of plague have infected five hundred Americans, and modern medicine could no more for them than the nostrums of the Dark Ages!

An epidemic of bubonic plague intruded into the busy life of the metropolis of San Francisco as the twentieth century began. In March, 1900, a resident of the city's Chinatown was taken ill and died. His death aroused much interest at the hospital where his cadaver was examined—the bacteriologists reported germs of plague. It was all very curious and exotic. It was a sensation for a few days and afterward it was forgotten. Then suddenly there appeared another plague patient, and another, and another, and by the end of the year there had been twenty-one victims of plague, and all died. The news of the epidemic was suppressed; the local authorities decided among themselves that twenty-one deaths in a population of over half a million was not newsworthy. The next year there were thirty cases, with twenty-five dead, and the news continued to be suppressed. Then came 1902, with forty-one infected and forty-one dying of Black Death—and plague could no longer be suppressed! Now thoroughly frightened, the city authorities gave orders for a vigorous anti-plague campaign. There was no doubt about the source from which the germs had burst. Rats and their fleas—infected rats from the Hong Kong epidemic of 1893—had finally made their way by shipboard across the Pacific to the port of San Francisco. The plague would not end until the rats of San Francisco were exterminated.

The shabby slum areas, in particular the Chinatown section, were cleaned up, wooden partitions replaced by concrete and steel, garbage-disposal regulations made stringent. Ships and

warehouses on the water front were fumigated, and rat shields made compulsory accessories for mooring lines attached to the ships anchored in the harbour. The native rats of San Francisco were pursued, poisoned, trapped, shot, and bounties offered for their dead bodies. Streets where plague had erupted were roped off and kept under strict quarantine while their rats were exterminated. It was not always easy to find rats to kill, for they lived in the most unlikely of places, such as those found in cold storage plants that for innumerable generations had lived out their full life spans at a temperature below freezing. One million rats were killed in that year.

The anti-rat campaign was effective. In 1903 and 1904 there were only eleven cases of plague and in 1905 and 1906 there were none. But in 1906 the citizens of San Francisco were distracted; earthquake and fire had come upon them and rats and plague were forgotten. The double disaster to men was not unkind to rats. They lived opulently on an abundance of uncollected garbage and masses of food exposed in the ruined buildings, and among the wreckage, in broken sewers and cellars they found lodging more plentiful than ever. Consequently, in 1907 there were seventeen cases of plague and seventeen deaths scattered over the city, but there were *none* in the cleaned-up Chinatown section.

The anti-rat warfare was resumed and plague ended in San Francisco. Since then single plague cases have occurred and will continue to occur from time to time. They are also reported occasionally from Texas, Florida and Louisiana, brief reminders by the germs of plague of events to come if rats are allowed to return to San Francisco or to any city where the germs are latent.

Meanwhile, in the midst of these frantic years an interesting phenomenon was noted in the fields and forests surrounding San Francisco. In 1905, the year in which no one in the city was infected by plague, it was observed that the ground squirrels seemed to be ill; they moved sluggishly and thousands of them were eventually found dead of no apparent cause. It was all very curious, but of interest only to naturalists who specialised in rodent species; everyone else was indifferent.

Twenty-three years after the first cases of plague in San Francisco, plague suddenly appeared in Los Angeles, four hundred miles to the south. Of the forty-one persons infected, twenty died. The health authorities were aroused and puzzled. What was the source of the germs; where had the rats come from? They had not entered by sea, for rat control measures on incoming ships were rigorous. Then they must have arrived by

way of San Francisco. If so, what had the rats and germs been doing for the past twenty-three years and how had they travelled to Los Angeles? These questions had to be answered. Plague was too serious to be dismissed with a trite remark and a shrug of the shoulder. Expert bacteriologists were assigned to investigate. They studied the disease intensively and performed numerous laboratory experiments; they recalled the epidemic among ground squirrels in 1905; and they submitted a report with an alarming conclusion buried in among the densely technical details: Many of the wild rats and ground squirrels of California are resistant to the germs of plague!

Humans may acquire resistance by artificial immunisation, but for rats and squirrels there is only one way: to have had plague and survived! There was no doubt that the Hong Kong rats had not remained in San Francisco, but had wandered into the forests and exchanged fleas with California wild rats and squirrels. The Los Angeles epidemic had come from San Francisco; the plague germs had travelled on the fleas of the wild rodents of California, transferring painstakingly from animal to animal over four hundred miles and twenty-three years. Now the immune sylvatic rodents of California could carry virulent germs of plague with impunity for their lifetime and could transfer the germs via fleas to other rodents and to men.

By order of the health authorities of Los Angeles, twenty million California sylvatic rodents were destroyed in order to forestall an American "Great Mortality." If intended to exterminate plague, it was a mighty but futile effort; plague could be defeated but would probably never be exterminated.

Plague is now established permanently in the United States in dormant form among new hosts and with a new name, sylvatic plague. The victims of the Los Angeles epidemic had died of sylvatic, not bubonic, plague. The germs were unchanged, as were the diseases, bubonic plague carried by the city and town rats and sylvatic plague by the wild rodents of the sylvan glades. There was a difference, however, not in the germs, but in the fleas. The fleas of wild rodents are wilder and more vigorous; they can jump higher and so bite higher on the human body. The infections of sylvatic plague erupt in the lymph glands of the armpits instead of the groin and thigh and the course of the infection is more rapid, turning invariably into an invasion of the lungs, and becoming the fatal pneumonic plague. Sylvatic plague is more deadly than bubonic plague!

The wild rodents of the United States, in the west and south, carry living cultures of dormant plague germs. The fleas of wild rats and mice, squirrels, chipmunks, marmots, gophers, rab-

bits and woodchucks are spreading the germs slowly to the east and to the north. In South Africa the germs live on in the gerbil, in Manchuria in the tarbagan, in Russia in the spermophile, in India in the bandicoot. Bubonic and sylvatic plagues sleep restlessly in Africa, in the Near East, on Madagascar, in Siam and Indo-China, in India, among the islands of the South Pacific and in South America. The great centres of plague, their endemic focuses where the germs are most numerous, continue to exist undisturbed and scattered over the world, in the province of Yunnan, on the western slope of the Himalayas, in central Arabia, in Africa at the source of the White Nile, in Uganda and in California. If the dormant germs should awaken from their slumber, dead rodents will litter the fields and forests and, unless we continue relentlessly our warfare against our age-old enemies, the rats, from them a "Great Mortality" of the future may arise.

CHAPTER IX

THE GERMS OF LOVE

TRADITIONALLY THE pestilences of ancient times were presaged by portentous phenomena, unnatural and supernatural, in the form of earthquakes, famines, floods, comets, eclipses of the sun and human-headed goats. These manifestations, reported regularly at every astrological conjunction, assumed significance on the rare occasions when their meaning could be made pertinent. And, if the pestilence should choose to arrive prosaically without fanfare, then indeed the soothsayer had need for a hindsight most remarkably acute and an imagination superbly flexible.

Certainly, as the last decade of the fifteenth century dwindled and Europe slowly emerged from feudalism, it seemed as though the malevolent fates that had guided the destinies of the nations and men of the Dark Ages had risen to a fever pitch of activity. For it was a decade of destruction, and major disasters were unveiled with unrelenting outrage. There were floods and crop failure, famine and the turmoil of war—and there was severe pestilence.

In 1489, Spain was ravaged by an appalling epidemic of typhus fever.

In 1492, the New World was discovered, a date of blackest disaster in the history of the natives of the New World.

In that same year a violent diphtheria epidemic struck Nürnberg, and a year later smallpox and measles swept through all Germany.

And in 1495 syphilis arrived in Naples.

Columbus had returned to Barcelona in 1493 from Haiti. Two years later, Charles VIII claimed Naples for France and led an army of mercenaries into that city. A few months later, King Ferdinand of Spain, disputing the French claim, in turn marched his army into Naples, including among his troops, it is said, those who had returned from the West Indies the year previously. For some curious reason, the meeting of the two opposing armies created no bloodshed, but rather mutual carousing and encounters of quite a different character, under the banner of Venus, not of Mars. Syphilis, not warfare, broke out in Naples.

Between the troops of Charles and of Ferdinand, and among the civilians of the disputed city, suddenly pestilence reigned. It was severe and loathsome. The skin rotted in leprous-like patches, festering ulcers destroyed flesh and bone, fetid cankers erupted and gnawed through the mouth, the throat, the nose and eyes and particularly the organs known as the "private parts." The services of the best of physicians were to no avail, although undaunted they applied profusely layer upon layer of healing ointments with mercury, sulphur and guaiacum and a multitude of esoteric compounds. Frequently death intervened and only the germs of the graveyard were able to cleanse the corrupted body.

The motley remnants of the six thousand mercenaries that had composed the army of Charles VIII were expelled from Naples in 1496, scattering each man to his homeland. In that same year, syphilis appeared in France, Germany, Switzerland, Holland and Greece. Scotland reported the "new" disease in 1497, Hungary and Russia in 1499. Vasco da Gama rounded the Cape of Good Hope, and both he and syphilis reached India in 1498. Jews and Mohammedans driven out of Spain carried syphilis to Africa. Meanwhile, the Holy Roman Emperor, Maximilian I, had issued an edict accepting syphilis as the punishment of God for man's carnal sin, St. Job had been assigned the task of patron saint and, before the fifteenth century ended, the "new" disease had received official status and was permanently established. Syphilis flourished everywhere.

Never in the long history of men and germs had a pestilence been propagated so far so fast, and, more remarkably, during an era which had never dreamed of railroads and steamships, automobiles and airplanes, or even the bicycle. Cholera, typhus, plague—these pestilences over many decades eventually penetrated into many parts of Europe; overnight syphilis saturated the continent and overflowed into Asia and Africa. Surely, unprecedented in mythology or medicine, it was a tribute to the limbs of Venus, more swift than the winged feet of Mercury.

Where, how, had syphilis arisen?

Unlike the scholars and scientists of later days who feverishly sought for proof that would assure them citizenship in the land where syphilis was born, the people at large coupled their horror and distaste for syphilis with whatever the national fervour of the times identified as their enemy nationals. They named and cursed the disease and their enemy with a compound epithet. The Italians who hated the French, for reasons which were then very obvious, called it the "French Disease." The British and the Turks, who for the same or other equally important reasons detested the French, agreed on the name selected by the Italians. On the other hand, the East Indians and the Japanese, who had been unmercifully swindled by Portuguese merchants, jointly referred to syphilis as the "Portuguese Disease." Naturally the Russians considered it the "Polish Disease," even as the French indicated their appreciation of the Italians by damning the "Italian Disease." The Germans occasionally had their nationality attacked, but the Hungarians were barred from consideration—the name "Hungarian Disease" had been reserved for typhus fever. Curiously, although syphilis had apparently first made its appearance in Naples, few called it the "Neapolitan Disease," which would have been proper, or the "Spanish Disease," which may have been correct. The Spaniards themselves blamed the people of the New World and called it the "disease of Hispaniola" in bitter resentment against those whom they had debauched and ravaged and all but exterminated.

When Hieronymus Fracastorius in 1530 related in verse how the shepherd, Syphilus, angered by the noonday sun that burned his flock, had cursed Apollo, and had been punished with a newly created disease, the origin of syphilis still remained unresolved. Belief in pagan mythology had waned with the rise of Christianity and Fracastorius failed to influence either popular or learned belief. The people of Europe preferred to believe that syphilis had arisen from the conjunction of Jupiter, Mars and Saturn in the sign of Scorpio, or from excessive rainfall, by

baneful air, by a liver that was too hot or too dry, from intercourse between a leper and a prostitute, from the eating of human flesh or of lizard meat, by the poisoning of the wells and the wine or through the wearing of linen shirts.

Among the scholars and historians, the debate on the origin of syphilis began at that time and it continues unchanged into the present, with each side expounding its own immovable opinion, an opinion that shapes permanently the evidence they find and colours indelibly the argument they present. For like the flounder, which always swims dark side up and light side down, the syphilis expert never changes sides.

Had syphilis always existed in Europe; was it merely the upsurge in Naples of an ancient ailment? Or was it indeed new in Europe but prevalent in the New World long before the voyages of Columbus?

In recent years, the debate has narrowed to a feverish search for pre-Columbian skulls in America and for pre-Columbian documents in Europe. (The search might with equal logic have turned towards European skulls and American documents.) If the markings of syphilis were to be positively identified on an Indian's cranium, dead and buried long before the arrival of Columbus, then syphilis must have greeted Columbus and his crew when they landed on New World soil. If syphilis could be found described accurately in an authentic European document predating 1492, then syphilis must be the Old World's gift to all mankind.

Thousands of Indian skulls have been rudely torn from their mouldering graves, separated from their unresisting skeletons and diligently studied. The scholars looked for the age of the bony material and for eroded spots which syphilis may or may not have carved upon the yellowed surfaces. Unfortunately, dates are not inscribed on bones by mother nature nor has she labelled their erosions, "Made by Syphilis."

So one set of scholars examines and says, "Yes, yes! No doubt about it! These skulls show definite evidence of pre-Columbian syphilis!"

And a second set of scholars examines the same skulls and says, "Oh, no, not at all! Not at all! The marks on these pre-Columbian skulls are positively not caused by syphilis!"

And a third set of scholars strolls by and glances at the skulls and says loftily, "Hrmph! Hrmph! Of course the marks are syphilitic erosions, but the skulls are modern; they are positively not pre-Columbian!"

Then the argument shifts to ancient manuscripts.

Some scholars cite the evidence of Gonzalo Fernández de Oviedo. He was the royal emissary to the Spanish possessions in America and he had written to his king how the crew of Columbus had acquired syphilis from the native women. "Does not that prove that syphilis came from the New World to Europe?" said these scholars.

"Certainly not!" retorted other scholars. "If Columbus's men caught syphilis from the native women, why was it omitted from the ship's log on both the first and the second voyage? As for Gonzalo Fernández, he couldn't recognise syphilis if it grew under his nose. He was not a physician, and besides he was overfond of New World wine! Why not read what Francisco Lopez de Villalobos had to say?" said these scholars. "He was personal physician to King Ferdinand. Lopez wrote frequently of syphilis, its causes and cure, but he said nothing of its American origin. He believed that Pharaoh had been smitten with syphilis by Jehovah!"

Then the opposing scholars rebounded with, "Roderico Diaz de Isla was also a physician and a contemporary of Columbus, and he described syphilis among the crew of Columbus soon after their return. He mentioned specifically the syphilis of Vincenti Pinzon, the pilot of the *Nina*, and that of Vincenti's brother Martin, who had piloted the *Pinta*."

"Bah!" sneered their scholarly adversaries, "Diaz was not a physician; he was a liar and a quack! It was this same Diaz who swore he saw Columbus land at Barcelona on his return from Haiti, when the official records state clearly that Columbus landed at Palos and went on to Barcelona by land! And it was the same Diaz who described cabbages suffering from syphilis! What of Nicolo Leonicello? He wrote that syphilis was known not only to Hippocrates but also to the ancients of Greece long before him. And what of the syphilis described in Hindu manuscripts of 200 B.C.?"

"It is perfectly clear why the logs of Columbus did not mention syphilis. The crew had not yet caught the disease. Syphilis was brought to Spain by the native women who accompanied Columbus on his return from the second voyage!"

"That is ridiculous! If syphilis came to Europe with the return from the second voyage of Columbus, then you have allowed very little time for the disease to spread. How was it possible for syphilis to spread all over Europe, Asia and Africa in a few months?" And the scholars added coldly, "Clearly our worthy adversaries are crediting the amorous encounters of those times with an incredible infect-and-go quality. Have they any idea at all how long it takes . . . ?"

And so it goes, argument on argument, becoming more and more dreary.

"Lichens, leprosy and ulcerous pustules are among the diseases of spring," Hippocrates had written many centuries before. "Ulcerous pustules" mean syphilis, said some scholars, and they pointed out triumphantly that the spring season is the time of year when syphilis is most likely to be propagated. And what of the writings of Clark and Córdoba? they asked. These men had observed that the tribes of the interior of South America and of the Sacramento Valley in California had made no contact with white men and were free of syphilis. And they claimed that it was the Spaniards who had brought syphilis into Puerto Rico.

The same scholars quote the eminent medical historian Hirsch who wrote during the nineteenth century. He had described how syphilis erupted in France in 1488 and spread from there over all Europe. But, he insisted, syphilis was known long before, beginning in China during the era of Confucius. He noted that it was particularly severe during the Tang dynasty of A.D. 618-906. It was also severe in Japan during the ninth century, and in the very earliest times had infected the people of India and been recorded in ancient Sanskrit documents. He narrated how, many centuries ago, syphilis had climbed up the slopes of the Himalayas and remained there as a prevalent and commonplace disease.

A manuscript of the year 1308 was discovered, describing a case of "leprosy." The symptoms of the "leprosy" correspond exactly with the symptoms of congenital syphilis, but some scholars doubt the age of the manuscript, as well as its translation.

A later manuscript, of the fifteenth century, tells how John of Gaunt died in 1408, how he was celebrated for his addiction to "venery" and how he suffered from "putrefaction" of his genital organs and of his entire body. Although John of Gaunt's malady seems most likely to have been syphilis, there are scholars who maintain with no additional evidence that this must have been an instance of cancer or tuberculosis of the genital organs. And then, by a masterly feat of misdirection, they reject the authenticity of the document, at the same time using it as evidence that syphilis did not exist in Europe at that time.

With a sense of relief, we turn to the fabulous and mendacious Captain Alphonse Dabry. By his own account the Captain had travelled extensively in the Orient, read ancient Chinese documents and studied with Chinese wise men. He had been introduced into the mysteries of the Orient, seen forbidden places

and gone where no white men had ever been before. When he returned from his travels, he wrote a book, *La Médecine chez les Chinois*, and in it he presented a detailed description of syphilis as seen in the writings of Huang-Ti in the year 2637 B.C. No one was ever able to verify his findings, and the wily Gallic "Münchhausen" during his lifetime proved himself a superb avoider of interviews and side-stepper of questions. Captain Dabry's writings are known wherever the origin of syphilis is debated, and he is always greeted with a unanimity of abuse and disdain from all scholars in the syphilis controversy. It is a pity his works are not better appreciated, for they are a pleasant interlude, the works of an entertaining and talented liar inserted among the earnest but tedious searchings into the dusty chronicles of bygone eras.

Amid the babble of manuscripts and skulls, and the slight brittle sounds of hairs being carefully split into a thousand parts, medical historian Sudhoff recently entered the controversy. He produced twelfth century manuscripts that meticulously described syphilis and apothecaries' prescriptions for the treatment of the "French Disease" and "Large Pox," and he dared anyone to say they were not authentic! He brushed aside mild inferences, timid deductions and half-hearted claims and denied that syphilis ever broke out in Naples, insisting that the epidemic was typhoid or paratyphoid fever! The irascible man went even further. He threw discretion aside and described Charles VIII and his expedition to Naples as "a myth," "a pack of lies," "a fairy story" and "an old wives' tale"! He doubted that Charles VIII ever marched against Naples and asserted that, if he did, his troops marched through without the slightest dallying. Syphilis, roared Sudhoff, has been known for ages in the Old World!

Today, the experts continue to fail to convince each other, and the search for manuscripts and skulls goes on.

It is probable that syphilis came from the Old World. It could more appropriately have arisen in the New. The natives of America in returning good for evil could have presented the Old World with syphilis, not a mere disease but a self-enforcing moral code. It was sadly needed in Europe, for, in the words of Hirsch, "the corruption of morals had reached a height which even contemporary writers tell us was without parallel in ancient time." The germs of syphilis had pronounced a new commandment, "thou shalt not stray outside thine own syphilis-free connubial bed," and the fear of the germs did its share in suppressing the rise of immorality at a time when law and religion had failed. If indeed western civilisation is based upon

marriage and the sanctity of the home, then the germs of syphilis may well have saved medieval civilisation from complete collapse.

While the experts disputed its origin, syphilis existed indisputably, and in Europe of the fifteenth and early sixteenth century the victims of syphilis suffered severely. The disease then was disfiguring and deadly and quite different from the uncertain chronic disease of modern times; only the method of transmission remains unchanged. The syphilitics were loathsome—they were exiled from their homes and even the lepers avoided them and drove them from the lazaret houses. The disease turned milder in later years and the cause of the change constitutes a problem the answer to which we do not know and may never find out with certainty. Perhaps the most deadly infections by the most virulent germs were buried with their victims and only the milder diseases and milder germs survived. Being the simplest and most reasonable of explanations, this theory may be wrong—nature seems to resent easy solutions to the problems which have required millenniums for their preparation.

Whatever the reason, by the middle of the sixteenth century syphilis had become milder, which may have been unfortunate. If it had remained as it started, deadly as plague and loathsome as leprosy, there might have been forced upon men a stupendous upsurge of morals and moralistic behaviour to which no exceptions would have been tolerated. The laws of morals and the laws of health would have coincided, and syphilis, instead of becoming more widespread, would like leprosy and plague have been nearer extinction. Instead, the history of syphilis has dragged on, attached to and hidden within the history of man, as a thread barely visible interwoven on the nether surface of the pattern of human events.

Shortly after Cromwell's army invaded Scotland, a pestilence known as "sibbens" appeared in both highlands and lowlands, reached its peak in 1725 and did not disappear until about 1840. It began with bright red protruding ulcers, resembling raspberries, sometimes progressing into destruction of the throat and mouth. The infections were transmitted by sexual intercourse, by skin contact and through contaminated eating and drinking utensils. The symptoms resembled tropical syphilis or "yaws" rather than European syphilis, and it is significant that sibbens literally means "wild raspberry" and that yaws is also known as *framboise* (raspberry) and *pian* (strawberry). If yaws and sibbens are indeed identical, then precisely how the germs managed to migrate from the darkness of Africa to the land of Bruce and Burns is unknown, although the general nature of the method is probably quite commonplace.

Yaws, a disease caused by spirochetes related to those of syphilis, was brought to Europe from Africa by Portuguese in the middle of the fifteenth century and by slave traders to the New World in 1500. From there it spread to parts of Asia, the East Indies and the Pacific Islands. Although it was considered a disease of coloured people, it was later found that yaws did infect white men—the germs of Venus make no distinction between the colours or races of men. During the early eighteenth century, American physicians described yaws among the slave women in North Carolina and Virginia and commented in consternation on the wide prevalence of the disease among white men in that locality. The medical men were dismayed by the unusual course that the infection followed—it attacked the nasal bones, causing ulceration and eventual destruction of the nose. Despite the warnings of physicians, southern gallants continued to pursue slave women and continued to lose their noses in consequence.

Some authorities claim that yaws is entirely unrelated to syphilis, that it is not even a venereal disease but rather propagates itself by contamination and is primarily a disease of children. Others maintain that yaws and syphilis are identical diseases which react differently because of the difference in climate. In their opinion a European who becomes infected with yaws in the tropics comes home to find that he has syphilis.

The native prostitutes of Guam are free of syphilis despite repeated opportunities to acquire it, but they are saturated with yaws and have an abundance of gonorrhoea. In the Fiji Islands, as in Guam, syphilis is unknown among the natives although the opportunity to incur it is amply available. The situation differs remarkably, however, in the Belgian Congo. There syphilis and yaws exist together—in the densely populated urban areas where syphilis is plentiful and yaws scarce, in the rural regions where syphilis progressively diminishes with distance from the cities while yaws correspondingly increases and in the sparsely populated jungles where yaws abounds and syphilis has become a rarity. In Haiti, Indonesia, Thailand and the Philippines, of eight million people who were examined by the World Health Organisation, two million were found to be infected with yaws.

Like syphilis, yaws may take any of a variety of forms. There is *gangosa*, which destroys the nose and the roof of the mouth. On the other hand, when the *goundou* form occurs, the nose far from being destroyed grows into an incredibly large, tumorous, pulpy mass. *Crab-yaws* causes painful sores to erupt on the soles of the feet and the victim awkwardly shuffles sideways in a crab-like manner to avoid the agony of putting his

weight on the flat of his feet. There are many other forms which are not dignified by specific names—ulcerations, swellings, fevers, headaches and painful deformations of the joints and bones.

Then men of Norway and Sweden were sea rovers; they wandered far over the sea lanes to every port of the world, and when they returned home they brought many strange objects with them. None was more rare and awe-inspiring than the invisible cargo of the germs of *radesyge*, the "bad disorder." *Radesyge* was indeed rare; it seemed as if medieval syphilis had been brought to eighteenth century Scandinavia, and it claimed many human lives in the few years that it was epidemic. In the medical records of that time, *radesyge* was described as yaws, leprosy, tuberculosis and scabies combined with a malignancy that none of these maladies separately possessed. But the modern experts who have studied *radesyge* have become convinced that it was indeed syphilis in an unusually violent and destructive form.

Other outbreaks of syphilis were surrounded with more personal traditions, for they honoured women who achieved renown because of the virtuosity with which they spread the disease. In the epidemic known as *Capistrello* in Italy in 1859, it is reported that one woman, whose name has been lost to history, became infected with syphilis allegedly by suckling a syphilitic child, and subsequently succeeded over a period of eight years in bringing syphilis to three hundred men in a town whose population totalled three thousand. Even more spectacular were the exploits of Margaretta, a prodigious woman who received recognition for an amazing achievement—Margaretta single-handed created a full-scale epidemic of syphilis that raged over an entire province in Italy, and the epidemic became known in her honour as *Margaritizza*.

Among the modern Arabs of the deserts of Syria and Palestine there continues to exist a mild syphilis-like disease known as *bejel*. It predominates among Arab children and causes ugly sores to erupt on the face, hands and other parts of the body. Some authorities describe it as a form of yaws, others say it is congenital syphilis that infects children while in their mother's womb and yet others insist it is neither of these but a totally different disease. The only certainties connected with *bejel* are the spirochetes that cause the disease and that are found in the infected parts of the body.

The words *Pinta* or *Carate* or *Quirico* have no meaning to most of the people in this country, but to those of Mexico, Venezuela, Panama and other nations of Central and South

America it describes a horribly disfiguring and painful disease. This is the *mal de los pintos* that Cortes described as "a kind of leprosy" that afflicted the Aztecs. Today, one quarter of a million Mexicans are known to suffer from *Pinta*; to the south and below the equator the exact number of victims is unknown, for it is so widespread it is beyond enumerating.

Pinta persisted as an enigma through many years of medical study, and not until 1938 was the enigma solved and *Pinta* classified as a syphilis-like disease caused by spirochetes. Previously it had been noted that the disease was perpetuated by sexual intercourse as well as by contact contamination, but the actual cause of the infection had been ascribed to conditions as far-flung and as varied as those attributed to the syphilis epidemic in Naples of 1495. The arrival of the science of bacteriology went unnoticed by the experts concerned with *Pinta*. During the past few decades, it was believed to have resulted from a mysterious series of mycotic or fungus infections, and Hecker reported that "the mycotic nature of this disease has been placed beyond doubt by the recent paper of Gastambide." No less than twenty-seven species of fungus were considered jointly responsible for *Pinta*, each one causing a differently coloured infection, one for red *Pinta*, others for blue, yellow, violet, black, grey and white with intermediate shades through the full twenty-seven in an unvarying sequence. It was as though it had been agreed that the various shades of colour through which a bruised eye progresses were each produced by a different cause each in turn developing and then disappearing to make room for the next.

Being accepted as a fungus disease distantly related to the "athlete's foot" of American swimming pools, *Pinta* was treated accordingly, and it was noted with dismay that no improvement, not to mention cures, had ever been obtained. In recent editions of bacteriology textbooks, it has been regretfully acknowledged as an inexcusable and shameful incident in the history of modern medical research. There had never been any evidence of fungus infection, no series of fungi had ever been observed, there had been no scientific research, but merely a conclusion with a bizarre description that many scientists accepted.

Once the spirochetes, the cause of *Pinta*, had been discovered, much pseudo-scientific debris remained to be separated from scientific fact. The clinical picture—the sequence of events—had to be reconstructed. It would have taken many years, for *Pinta* like syphilis develops slowly, with many complex manifestations that imitate and are easily confused with diseases caused by other germs. But scientist Aguirre Pequeño of Mexico found him-

self unable to wait patiently while the years passed, while patients were examined and case histories studied until the facts were chiselled free of fantasy and the clinical picture of *Pinta* emerged in hard and clear relief.

In 1939, impatient scientist Pequeño inoculated himself with *Pinta*. For three and one half years he methodically examined his body and noted his every reaction, and he reported regularly to his colleagues so that they might confirm or add to his observations. At each of the four places where Dr. Pequeño had inoculated himself, festering ulcers—*pintids*—appeared, slowly spreading and becoming larger each day. Then small new *pintids* broke out all over his body and they too grew and spread until his whole body was covered with a mass of infectious sores, resembling those of leprosy. As an acrid nauseating odour arose from each pintid, Pequeño had to forego all of his social activities—the smallest of his discomfitures.

On Pequeño's body, the *pintids* each passed through a gamut of many colours and finally healed as a white spot of irretrievably dead skin. But Pequeño was not finished with *Pinta*, for, as he soon discovered, *Pinta* had barely begun. Ugly ulcers erupted on his genital organs; his hair fell out. Walking became anguish as the soles of his feet turned into a mass of sores. The *pintids* spread to the palms of his hands, with pain so intense that his writing became illegible and he had to dictate his observations. Months passed, new *pintids* became fewer and finally ceased to appear. All over his body they slowly healed, leaving white spots everywhere and heavy layers of dead and calloused tissue in thick horny masses on the palms of his hands and the soles of his feet.

Pequeño now realised there was yet more to come. Like syphilis, the spirochetes of *Pinta* flirt with the human body for the first and second stages of the disease, causing more pain and embarrassment; the deadly third stage, the nerve invasion, was still to follow. Meanwhile, penicillin had become available and would end his ordeal miraculously, but it would also end his experiment. Pequeño rejected penicillin; the experiment continued.

He braced himself for what he knew would be next—"lancinating fulgurating girdle pains" announcing the arrival of the spirochetes in the nerves and spinal cord. And he was right. The pains came in due course, agonising and unbearable as knife thrusts in his abdomen, continuing day after day without relief. After three and one half years of suffering, this was the final unendurable torture. Pequeño collapsed. His colleagues injected penicillin in massive dosage, the advance of the spiro-

chetes was checked, *Pinta* receded and disappeared. His body covered with dead white spots, his feet and hands heavily caloused, with painful memories prodded by occasional spasms in his abdomen, Pequeño lived to write a comprehensive first-hand report on *Pinta*.

Dr. Pequeño wanted no sympathy. He had solved a problem that had plagued his countrymen since long before Cortes had written of New World "leprosy." He had proved that *Pinta* was a syphilis-like disease!

CHAPTER X

THE MORALS OF DISEASE

SYPHILIS WAS recognised in 1495, named in 1539, and flourished for more than two hundred years before men were certain of its cause. There was an obvious connection with the sex relation, but that knowledge required neither scientists nor scientific deductions.

The famed John Hunter in 1786 inoculated himself with infectious matter from a gonorrhoea patient to prove that syphilis and gonorrhoea were differing manifestations of the same contagious disease. Shortly thereafter Hunter was gratified when the signs of both syphilis and gonorrhoea appeared on his body! The explanation as we know it now was sordidly commonplace: the patient from whom Hunter had taken the germs was suffering from both diseases. Syphilis ruined the remainder of Hunter's life; he postponed his marriage for several years, his health failed and he died suddenly of syphilitic heart failure during a heated discussion of that disease. He died believing that the two diseases were one, and in his honour the primary infection of syphilis was designated the "Hunterian chancre." Despite his error, Hunter had made a contribution. He had confirmed the unproved opinion of many intelligent physicians by demonstrating that syphilis was perpetuated by contagion and not as generally believed by "internal morbidity" or the "unnatural heat" of sexual relations.

A few years later, the same experiment was performed by another physician. François Broussais, for many years a bitter antagonist of Hunter, ridiculed the Hunterian experiment, hint-

ing darkly that Hunter may have acquired the disease by a procedure that was neither scientific nor experimental. Broussais denied that syphilis was a contagious disease but he made no attempt himself at a direct approach to the problem. Possibly he had seen too many cases of syphilis in its advanced stage, or perhaps he was influenced by the condition of Hunter's health after the completion of the "successful" experiment. Instead, Broussais, discreetly instilled the ardour of science into one of his own students. The student, with full trust in the teachings of his master, inoculated himself with matter from a syphilitic sore. He promptly contracted a most painful and loathsome form of the unpredictable disease of syphilis. Knowing that his condition was hopeless, that the disease was incurable, he took his own life. The story ends abruptly; it fails to inform us of Broussais' reaction, whether or not he changed his opinions, and the name of the over-zealous student is buried with him in an unknown grave.

Fifty years later, in 1838, Philippe Ricord separated the identities of syphilis and gonorrhoea without heroics and without crucial experiments. Previously, the sixteenth century physician Alemar had almost concluded that syphilis was a contagious disease transmitted by sexual relations, when he was called upon to render professional services to an "irreproachably moral" personage. His patient unmistakably had syphilis, but Alemar could not believe that so moral a man would acquire it in "that" way, and reluctantly he wrote that syphilis was perpetuated by "corrupt air." Perhaps Ricord profited by Alemar; he probed patiently with a detached and merciless cynicism, the only rational approach to a disease obscured by undercurrents and social pressures. Ricord's method began with the assumption that everyone who was alive was potentially likely to acquire a venereal disease. He listened to the shrill and indignant denials of his impeccably virtuous patients as attentively as to the unabashed confessions of the hopeless degenerates, and believed only the evidence his own examinations uncovered. His observations were meticulous, his conclusions logical and in culmination he painted a clinical picture of syphilis and gonorrhoea, two distinct diseases, related only by the manner in which they passed from one human to another.

Except that the germs of syphilis were not discovered, Ricord described the disease as it exists today, a disease which infects people everywhere with no exception allowed for professional status or social position, which is perpetuated by the primary sex act and which occurs by other means only by rarest accident.

After Ricord, another half century elapsed; many germs were

identified by Pasteur, Koch and their followers, but the germs of syphilis eluded all the enthusiastic pioneers in the science of bacteriology. Protozoologist Fritz Schaudinn in collaboration with bacteriologist Erich Hoffmann became the first man to see the spirochetes of syphilis, thin, flexible, colourless spirals like minute corkscrews slowly rotating in the human blood stream.

The discovery of a new germ is followed invariably by intensive efforts at a culture in the test tube. The germs of syphilis proved elusive and frustrating. They flourished in the living tissues of men, but not in the test tube. When fresh bits of animal flesh or fertilised hen eggs were provided, they grew, but they lost their virulence and could no longer cause syphilis. Grown on artificial culture, they remained spirochetes but not the spirochetes of syphilis.

It is now acknowledged that in nature the germs of syphilis perpetuate themselves only in the culture nutrient provided by the living body of man. They invade through a minute break in the skin and for three weeks to three months there is no sign of their invasion. Yet the germs are growing within, and they may transfer to other humans under suitable circumstances even though the first tangible evidence of syphilis is not apparent. Eventually a syphilitic ulcer appears, painless and bright red, and slowly grows to the size of a penny, then as slowly heals and disappears with scarcely a trace to indicate that it had ever existed.

Several months elapse before the germs begin the second phase of syphilis. Headaches and mild fevers recur periodically, a feeling of illness comes suddenly and slowly leaves to return again and again. The skin breaks out into rashes and pimples, annoying and irritating, healing and breaking out anew on the genital organs, the palms of the hands and the soles of the feet. Canker sores appear and disappear repeatedly in the mouth, the lymph glands of the groin become swollen and tender to the touch. These signs and symptoms of secondary syphilis reach a maximum, then gradually become less severe and less prolonged, with longer gaps between each siege over a four-year period. Finally, no more eruptions appear on the skin or in the mouth, the fevers disappear and illness no longer returns. The second act of syphilis has drawn to a close.

The stage, the human body, has been cleared for the third act. The curtain may rise and the last act of syphilis begin at any time. Frequently death by old age cancels the performance. The second phase has been tedious and embarrassing but not deadly. Sometimes it is exceedingly mild or may be omitted entirely,

and this is unfortunate, for then the third is certain to be filled with sound and fury.

During the intermission, the germs appear to have vanished completely, but they still lurk in the innermost recesses of the body, deceiving the blood tests and evading the intimate scrutiny of the microscope. Only other syphilis germs are aware of the secret presence of the disease and are powerless to invade while a trace, however subtle, of the first invasion persists. A syphilitic is certain that his syphilis is entirely gone only when he succeeds in becoming reinfected with syphilis.

Suddenly the germs again become active; science does not know why. Some say that it is not the germs that awaken, for they have always been awake, but that an allergic reaction ushers in the last phase of syphilis.

Certainly, when the last phase begins, the germs have changed from an annoyance to a deadly menace. Wherever they have been hidden in clusters, a festering mass of swollen flesh rises into ugly tumorous growths, to die and decay. The decayed spots penetrate through the skin to the bone beneath, eroding the membranes of the mouth and rectum, forming dead areas in the liver, kidney, brain, heart; no organ is immune to destruction by the germs; any or all of them may be riddled with syphilitic ulcers.

When the germs have invaded and destroyed the heart valves, the heart exhausts itself into death as it futilely pumps over and over again the regurgitating blood. Or, if the coronary arteries are destroyed, the heart, deprived of its blood supply, stops abruptly. The arteries of the body are favoured lodging places for the germs and the arterial walls become hard and brittle. High blood pressure, ruptures, internal bleeding and eventual death follow.

The major artery of the body is the aorta and as it leads from the top of the heart carrying blood to the entire body, it makes a sharp bend backward. The bend of the aorta receives the full thrust of the blood pressure as the blood is forced from the heart, its tough muscle wall stretching with each surge of blood and elastically rebounding. It is at this great arterial bend that the germs frequently collect and erode the muscle walls. Body repair cannot replace rotted muscle, and scar tissue fills in the damaged spots. Like a weak point in a garden hose under full water pressure, the scars "give" under the continuous pounding of the blood flow, and, since there is no elastic rebound, the weakened spot balloons into a thin bubble of stretched scar tissue. The bubble, or aneurism, grows larger until finally stretched beyond its limits, the aneurism bursts. Inside the body

blood spurts into the chest cavity, and death is instantaneous.

When the brain is invaded by the germs, the last act of syphilis may be ended suddenly, or it may drag on for many dreary years.

If the fragile blood vessels of the brain are eroded, eventually the blood will spurt out and a fatal apoplectic stroke will terminate syphilis. If the germs have been gnawing at the thinking part of the brain, the cerebrum, the ultimate conclusion is not less final but it may stretch out interminably. For the "thinking" of the brain does not immediately cease as the infection progresses. The syphilitic brain gradually becomes detached from the realities of worldly existence. It ignores more and more the evidence of the senses from which it is slowly being disconnected, preferring to believe delusions. This is "paresis." The victim passes through long intervals of violent and pleasant fantasy. At first the fantasies are patterned on distorted imitation of remembered reality; then they weave into internal vagaries as the nerve impulses aimlessly traverse the tracts of the brain. They become increasingly meaningless and abstract, until they are completely disconnected from the external world, achieving the non-objectivity of total insanity. As non-objectivity must inevitably end, either in the brain of men or in their art, there follows that inertness and paralysis of imbecility which is the outward evidence of total aloofness from the world of reality. The syphilitic retrogrades to the formless brain and useless muscles of pre-birth existence; he becomes a fœtus without its womb.

If the brain is spared and the spinal cord attacked instead, the germs have preference for certain nerve tracts, and syphilis becomes *tabes dorsalis*, better known by its effects as "locomotor ataxia." There is no insanity, no pleasant dreams, no relaxation in mindless abstractions, but only cruel reality. As the victim walks, he feels a vague insecurity and awkwardness and stumbles over nothing. The feet move sideways when the brain has directed forward motion; they come down on the ground with a hard stamp when smooth lowering was intended. They are raised too high and dropped too soon or too late, and, if the eyes fail to guide, the victim falls in a tangle of arms and legs. As the disease progresses, feet and legs are thrown in every direction, and, despite careful concentration, walking becomes a trial-and-error motion, the body twists violently to compensate for false movement, stumbling becomes more frequent, walking slows to a crawl, then to a shuffling creep, then becomes entirely impossible. With a healthy body and firm muscles the syphilitic spends the unpleasant remainder of his life in bed. Sores erupt all over his body and they fail to heal; he loses con-

trol of his bladder, becoming incontinent, and the joints of his feet and legs degenerate into painful masses of deformed and rheumatic bone.

In this, the last phase of syphilis, the victim is no longer contagious. His condition now endangers only himself.

The germs of syphilis have a certain meaning for the physician, the scientist and the medical historian, but they have other meanings and significance. Human lives are involved, those of the men and women whom the germs have infected. In the last phase of syphilis, the germs invade the human brain where they probe at random, exaggerating or depressing human emotions, and sometimes dictating human behaviour.

Many men and women, renowned and infamous, have been associated with the germs of syphilis. The treacheries and passions, the violent intrigues of Cesare Borgia may have come from the syphilis that he inherited from Pope Alexander VI. Syphilis infected the brain of Ivan the Terrible and the germs stimulated the brain centres that create maniacal rages and inhuman cruelties. The germs that are said to have gnawed at the brain of Herod may have initiated the intricate series of events that led to the crucifixion of Christ.

As a young man, Schopenhauer contracted syphilis and from it he acquired a distaste for the female sex that remained with him throughout his lifetime.

The germs of syphilis thrived in the body of King Henry VIII and thereby altered profoundly the course of history and religion in England. The germs were passed on to Queen Catherine and in turn to each of the wives who followed. Henry fathered many children but with few exceptions they died in syphilitic stillbirth. A son survived, to die after a few years of syphilitic existence. One daughter lived on with body and mind distorted by congenital syphilis, to become Bloody Queen Mary. The other daughter, Elizabeth, seems to have escaped the germs but her aversion to marriage may have been connected with syphilitic infection. When Henry divorced Catherine for failing to provide him with a male heir, he was excommunicated by the Pope, and Henry responded by suppressing Roman Catholicism and founding the Church of England.

In czarist Russia, it was believed that the Mad Monk was not really mad—only syphilitic. In the brain of Rasputin, the germs stimulated sensuality and not only influenced the life of Rasputin and his dupes but also undermined the throne of Russia. The orgies of vice in which the Czarina was involved became a public scandal and the peasants of Russia lost their reverence for the

nobility. Then, it is said, the germs helped further to raise the red flag of revolution. By stimulating Nicolai Lenin into fanatic and single-minded purpose, they destroyed Russian czarism and replaced it with communism.

There was another syphilitic, but he did not engage in cruelties or sensuality or revolution. He only dreamed. It was a syphilitic dream and it was a grandiose lie. Nietzsche dreamed of a race of supermen who were destined to rule all lesser men. He wrote of his dream and then he withdrew completely into the dream world created by his diseased brain. Another syphilitic, Adolf Hitler, responded both to the dream of Nietzsche and to the writhings of the germs in his own brain. He convinced millions of Germans that they were the supermen of Nietzsche, and he tried to convince the rest of the world; before his crusade of insanity and syphilis was ended, many millions of people had died.

Syphilis has become an intimate and essential part of the morals and moralistic laws of mankind. Morals, their description, their definition and regulation are intangibles that come and go with the times, rising to hysterical heights or receding to indulgent lows. Apart from morals and their standards, it is agreed that syphilis is perpetuated by sexual activity away from the connubial bed. Terms such as courtesan, concubine, exchange wench, mistress, tart, call girl, housekeeper, lady and gentleman friend, office wife with varying shades of meaning establish themselves in each succeeding era and are replaced in the next by others. Only the whore and the prostitute remain unchanged; they are as real as the germs and the disease. They exist today as they did when syphilis flared during the Middle Ages. Then there were no cures, no treatments. Today we have miracle drugs, health campaigns, lectures, drives and blood tests, but the germs of syphilis continue to flourish where other germs given equal attention would be eliminated. The germs of syphilis have the advantage over other germs, for they hide and prosper in the obscurity of the sex relation, the most private and secluded of the human body's functions.

Syphilis is an "ungentle" disease and syphilitic patients are reluctant to seek medical care. They visit the physician only when the symptoms of their ailment become severe; then they withhold information and lie, welcoming an error in the diagnosis of their condition.

At the present time, despite the arsphenamine of Paul Ehrlich and the penicillin of Alexander Fleming, three hundred thousand people in the United States become infected with syphilis each

year, and of these fifteen thousand die. Most authorities claim that these figures are far too low, that many cases never see a physician and that many deaths ascribed to heart failure, high blood pressure or apoplexy were predetermined years before at the moment the germs of syphilis entered the victim.

If a pregnant woman is syphilitic, the germs penetrate the foetal membranes to infect the unborn child. The embryo emerging into life with congenital syphilis may die as a foetus in a syphilitic miscarriage, or the infant may be born dead in syphilitic stillbirth. If he succeeds in entering the world, he will live out a bleak existence damned by a warped brain and a deformed body. The miracle drugs destroy the germs, but they have not altered congenital syphilis. Before penicillin and today after penicillin, the rate remains unchanged in the United States, fifteen thousand infants each year are marked by the germs of syphilis before they come into the world.

Syphilis, the disease that should not be in our modern era, continues to exist. It could readily be eliminated overnight to become an extinct disease with an interesting history. The syphilis epidemic has lasted at least five centuries and it continues today, and, unless there are improbable changes in the fundamental behaviour of humans, it will accompany men far into their future.

CHAPTER XI

THE GERMS OF MARY MALLON

TO MEDIEVAL physicians, all diseases were of two kinds—brief fevers and continued fevers. To them, typhoid fever was merely a continued fever and it was treated like any of the continued fevers, or, for that matter, like any other ailment—all the complaints of humanity were treated by the letting of blood. And specifically for continued fevers, the medieval practitioners recommended that no less than thirty-five separate bleedings be inflicted on the same patient. Since these physicians kept no records and knew nothing of statistics, they failed to note that their patients frequently died while other sufferers who could not afford a physician often continued to live.

The zealous outpouring of blood did not end with medievalism, but continued far into the nineteenth century. In America

its great exponent had been Dr. Benjamin Rush; in Europe, Dr. François Broussais. But Broussais had the advantage; he had learned the art of bloodletting as a soldier, and when he changed from sword to lancet he proceeded to let even greater torrents of blood. To justify his sanguinary talents, he wrote lengthy treatises on his concepts of disease and the art of medical practice. Many physicians read his works and, impressed by what they read, followed where he indicated and did as he did, even though they did not understand the meaning of what he said.

"There is no such thing as contagion," said Broussais. "All disease is aroused by local irritation of the internal organs, caused primarily by excessive heat. Disease is created from within, not acquired from without," he declared, "and nature has no healing powers. The body must be weakened by copious bloodletting to allay the heat and abort the internal irritation."

Unquestionably, more blood flowed by his lancet than had ever been let with his sword, and that which pointed steel failed to accomplish his leeches achieved. Forty-two million leeches had been imported into France in 1833 and with them Broussais diligently supplemented his lancet, fifty leeches applied at one time to one victim, until his own students were appalled and repudiated his doctrines. But loss of blood from disease-weakened bodies continued for many years after Broussais had been discredited; it had been the theory by which Broussais justified his bloodletting that his students and fellow practitioners rejected, not bloodletting itself.

In the nineteenth century, typhoid fever hid in the shadow of typhus fever. Both ailments brought fever to their victims and both raised spots upon their bodies. It was an unfortunate coincidence, for the other symptoms differed and the diseases were transmitted by different means, typhus by body lice, typhoid by body filth. And the perplexed physicians groped their way through double confusion as they studied the feverish bodies of their patients.

When the truth began to emerge, it did so in erratic and uncertain steps. First, Bretonneau in 1826 described how certain cases of typhus caused abscesses in the intestine while other cases did not. Three years later, Louis reported a new form of typhus fever for which he proposed the name typhus-like or typhoid. A few years later, his student Gerhard carefully compared and contrasted typhus and typhoid and proved clearly that there were two separate and dissimilar diseases.

But the steps forward toward truth were as though they had never been taken. Unperturbed by Louis and Gerhard, Kuehler

published in 1844 the "complete" proof of the identity of typhus and "so-called" typhoid, and three years later, Waters "absolutely" confirmed Kuehler in every detail. Eventually Louis and Gerhard were vindicated, but not until many years had passed and many people had died of typhoid fever.

William Budd had demonstrated conclusively in 1856 that typhoid was perpetuated and transmitted by human filth. Unimpressed by Budd, Pettenkofer of cholera fame propounded a corollary to his Law of the Soil Water, viz., ground water at an unusually high level in the soil followed by a sudden lowering produced not cholera but typhoid fever. Bennett believed that typhoid was caused by inhaling the fragrance of flowers, particularly those of the mangrove swamps of Africa; Löw insisted that some typhoid cases resulted from the aroma surrounding putrid hides and others came from eating American bacon. Murchison furnished positive proof for the origin of typhoid fever from the emanations arising from decaying organic matter and believed that "hot baths and two to six leeches applied over the right iliac region often gives great and immediate relief."

While the prominent medical man debated, the search for the cause of typhoid epidemics was continued by others, and slowly and painfully, through the efforts of many anonymous contributors, a pattern of connected events began to emerge.

In 1880, the "contagious matter" of typhoid fever which Budd had hypothesised a quarter of a century before was shown by Karl Eberth to be germs in the shape of straight bits of string. But the sewer gas, climate and weather theories and soil water laws of Pettenkofer were difficult to exorcise. Although the germs of typhoid fever had been indicted and had been found guilty, many years elapsed with trial and error and bitter tragedy before all concurred in the verdict. When, in 1884, Murchison wrote his celebrated *Treatise on the Continued Fevers of Great Britain*, he recorded numerous instances of the spread of typhoid from one victim to others in repeated association with contaminated wells, stopped-up drains, leaking sewage and infected milk. Nevertheless, Murchison wrote that he "cannot accept the contagion theory of enteric (typhoid) fever infection" and in his treatise the newly discovered germs of typhoid were listed among the many scientific curiosities peculiar to the disease.

Indifferent to their exposure and their influence on the ways of men, the germs of typhoid fever continued to live as nature had designed, on human bodies and by the illness and death of men. They enter through the mouth and migrate to the intes-

tine. They penetrate into the living cells, live and reproduced their kind and use the vital cell substance for their nutrition. One after another, the cells of the intestinal lining are destroyed. Soon there is an opening, a gaping ulceration. Two to three weeks later, when the ulcerations have become as numerous as moth-holes in a woollen garment, typhoid fever begins.

The germs of typhoid pour through the ragged gaps into the blood stream. They penetrate into every recess of the body. Headaches begin, becoming increasingly severe, as chills and fever alternate. A feeling of illness pervades the victim and he is forced to take to his bed. The fever slowly rises over a week, increasing as the germ invasion increases, and reaches a peak during the second week. There is no sign of the fever abating. The nose bleeds, the lips become dry and cracked and the victim is tortured by an unappeasable thirst. The germs reach the brain, and the victim responds, sometimes with a stuporous calm, sometimes with delirium. The mental vagaries of the poisoned brain frequently take a peculiar form; victims will claim violently that they are not ill, will resist treatment, and, according to Murchison's treatise, "those who insist that there is nothing wrong with them usually die." Bright red spots appear on the body where the germs have clustered in small groups in the skin and eroded the blood vessels, marking where the germs have gathered. The "rose spots" remain for a few days, then fade as the germs travel on to new spots. The second week of typhoid fever ends, but the disease continues.

The third week of typhoid brings a crisis.

If the fever has not subsided at the end of the third week, then the "prognosis is unfavourable." If vital organs are irretrievably damaged, there is death instead of recovery.

During the last decade of the nineteenth century, the germs and the disease they caused were finally acknowledged by all; the polemics and uncertainty of the past had come to an end. But epidemics of typhoid fever continued to erupt in villages and in cities, in Philadelphia, Chicago and Newark as well as in Berlin, Paris and Vienna.

The twentieth century arrived. The problem of typhoid fever had been solved. It no longer was confused with typhus, and it was as readily distinguished from other ailments. The cause of typhoid was known. The germs were easily identified in the bacteriology laboratory. The means by which they spread, their breeding places in sewage, in contaminated food, infected vegetables, filthy water and milk, all had been exposed. But the germs of typhoid fever persisted.

There were nearly half a million typhoid fever cases each year in the United States as the twentieth century began, with recurring outbreaks in Chicago, Philadelphia and hundreds of smaller municipalities throughout the nation. Each year typhoid fever invaded army camps, farms, "health" resorts, picnics and banquets. In the city of Ithaca, New York, where the population was only thirteen thousand, in the year 1903 there were over a thousand victims and one hundred dead of typhoid fever.

In the city of New York, typhoid continued to erupt year after year, leaping from home to home and street to street, from East Side to West Side, from Harlem to Park Avenue, from Times Square to Brooklyn, in an incomprehensible sequence. There was no connection to be found between the separate outbreaks. The laws of health were vigorously enforced in New York, but the germs of typhoid survived and flourished instead of dwindling and vanishing. Despite physicians and hospitals, cleanliness of food and drink, hygiene and sanitation and quarantine, there were four thousand cases of typhoid in 1906, and one thousand of them died. Many of them had been residents of wealthy homes where the food and drink and sanitation could not be suspect, yet the disease was there, and the germs that caused it were found in the bodies of the victims. The physicians and bacteriologists were perplexed. Something was being overlooked, some vital factor was missing, some secret of the germs of typhoid remained undiscovered. The ghosts of Pettenkofer and Murchison again began to hover over the scientific and medical circles where typhoid fever was studied and discussed. The Law of the Soil Water was resurrected; sewer gas caused typhoid fever, not germs, said Dr. Horrocks in New York City, a poisonous gas caused by the interaction of water with soil washed into the sewers. A commission was appointed to investigate sewer gas. They collected samples, analysed, poured into test tubes and injected into guinea pigs. The commission found no connection whatsoever between typhoid fever and sewer gas.

It was an enigma, and it was solved by a brave and unwilling martyr.

There is a tradition of sorts of willing martyrdom and self-sacrifice among those who venture into the deadly alien life of the world of germs. Men and women risk disease and death from the germs they study and many are victims of the wild life they seek to cage in test tubes. They do all they can do avoid risk, and they confidently expect to be able to outwit the dim intelligence of their dangerous captives. Occasionally they face unknown behaviour, or encounter accidents or negligence, and

sometimes they are carried away by their own zeal for knowledge. They suffer misfortune. There was misfortune for Donnelly and Macgruder and for Jochmann and Prowazek in Serbia, for Husk and Ricketts in Mexico, for Sacot in Egypt, for Lazear and the yellow-fever martyrs in Cuba, for the men of the U.S. Public Health Service who studied the pestilence in Bitter Root Valley, for Noguchi and Thuillier and Carrion and Luthje and Cornet and Schussler and Conneff and for many others, both those whose names and works have been celebrated and those who are known and mourned only by those close to them. Into this illustrious company was forced a resentful martyr who lived bravely and died resigned and bewildered.

Miss Mary Mallon was not a scientist; she was a good "plain" cook. She changed employers every few months and no reason is given by her biographer to account for her restless spirit; perhaps she felt the need for frequent change in her surroundings and for new faces around her; perhaps she was unlucky in her choice of employers. She was pleased to work or not, to cook for a year or less, then to move to a new kitchen. She was pleased on her "day off" to meet friends and visit with them at their rooms, to mingle with the crowds uptown on Fourteenth Street, to walk in the park or sit for hours on a bench, to shop or gaze idly into shop windows. All of these gave her pleasure, until the germs of typhoid fever stealthily intruded and rudely disrupted forever her simple and satisfying routine of existence. The intrusion had taken place some years before in the north of Ireland when Mary had recovered from an attack of typhoid fever. The intruding germs persisted in her body and it was these germs, those that had failed to kill her body, that were to destroy her life. Mary Mallon, healthy and robust and now immune to typhoid fever, came to America and the germs accompanied her. Unknowingly, she carried the virulent germs within her, and wherever Mary went, typhoid fever followed.

In 1900 typhoid fever followed Mary to a home in Mamaroneck, New York, where one of the family became dangerously ill. The illness was diagnosed, the germs identified as typhoid, but neither the attending physician nor the local health authorities could understand how the germs came to Mamaroneck or why they selected just one family in that town.

The next year, Mary moved to a new job and typhoid came with her into the kitchen, to add another case to the health records of New York City.

Another year ended, and her term of employment, and the germs of Mary Mallon moved with her to Maine, to the village of Dark Harbour. In that village lived a family numbering

eleven members, and they began to sicken one by one until all had taken to their beds. All were prostrated, all except the master of the household, who had once had typhoid and was immune, and the cook Miss Mary Mallon. She worked hard, taking care of nine patients, and her grateful employer gave her a fifty-dollar bonus. The medical experts studied the disease in Dark Harbour and could not understand how typhoid germs were able to enter an isolated village and strike only one household in that village with an incredibly accurate malignancy.

Nothing is known of Mary's activities during the year 1903; it may have been momentous or it may have been uneventful with respect to the germs that inhabited her body. Mary herself doubtless continued to live her simple life. But in 1903 there was a disastrous epidemic of typhoid fever in Ithaca, New York. A study of the epidemic had led to the conclusion that the entire outbreak originated in one home where the first case had been reported and where, it was noted, "a person by the name of Mary Mallon had been employed as a cook." It may have been a coincidence of names, or it may have been that the illness and death in Ithaca that year were the work of the germs that had lived with impunity inside the Mary Mallon of this chronicle.

The year 1904 arrived and Mary worked as cook for a family in Sands Point, Long Island. The germs of typhoid fever continued to live actively within her, for of eleven members of the family four sickened with typhoid. Still the secret channel through which the germs made their way into the household remained undiscovered.

Months passed and it was now 1905, another blank page in the chronicle of Mary Mallon. She lived through the year, unknown, submerged among the millions in New York City and the surrounding area. There are many homes in this wide expanse where she habitually sought work; any of them may have hired a cook who remained for less than a year and who was called Mary. And there were many outbreaks of typhoid fever within this area; some of them may have been caused by the particular germs of typhoid carried within the body of Mary Mallon.

The next year, as typhoid fever claimed its customary toll, one among the many victims lived in a home in Tuxedo, New York. There in the kitchen Mary Mallon did "plain" cooking.

Later during the same year, fresh peaches in ice cream were served to a large family in Oyster Bay, Long Island. The peaches were carefully sliced and peeled and served by Mary Mallon's own hands, and a few days later six members of the family felt feverish and suddenly collapsed. Their illness was diagnosed as

typhoid fever; the source of the germs could not be traced.

The arrival of 1907 marked a turning point. The germs of typhoid fever dwelling within Mary Mallon for many years had spread sickness and death undetected and unchecked, and there seemed to be no end to their depredations. But a day of reckoning was inevitable and eventually it arrived when a Dr. Soper appeared. Physician and epidemiologist, an expert on typhoid fever, consultant for the epidemics in Ithaca and Watertown, Dr. George A. Soper was the reckoner.

The day of reckoning came while Mary Mallon was working for a family living in a brownstone mansion on Park Avenue in New York City. Soon after Mary had taken charge of the kitchen, the laundress sickened with typhoid fever and recovered. Then the only daughter of the family sickened with typhoid fever but failed to recover. Dr. Soper was summoned and, though he had never met Mary Mallon, he had traced her career soon after the epidemic in Oyster Bay and suspected that the germs were within her body. Now he found typhoid fever and Mary Mallon in the same household.

According to Dr. Soper,* "Mary Mallon was then about forty years of age. She had a good figure but a little too heavy. She was five feet six inches tall, a blonde with clear blue eyes, a healthy colour and somewhat determined mouth and jaw."

Dr. Soper walked into Mary's kitchen and attempted to speak diplomatically to her. How can one diplomatically tell someone that she has given typhoid fever to at least twenty-four people, that she had caused death and was a menace to the citizens of the community? And then how does one diplomatically ask for specimens of someone's blood, urine and fæces? Demosthenes would have been baffled but Soper tried.

"She seized a carving fork and advanced in my direction. I felt rather lucky to escape; it might have been a carving knife. I confessed to myself that I had made a bad start. I was positive that Mary had produced all of the typhoid cases. No doubt her hands played a part in it. They became soiled when she visited the toilet, but whether from her urine or from her fæces I had no way of knowing. I wanted to find out."

Dr. Soper's retreat was only temporary. He returned with another physician, but the reinforcement proved inadequate. The men of medicine were again put to rout by the formidable carving fork.

But Dr. Soper was as persistent as the germs of typhoid fever and as determined as Mary Mallon. He did not attempt to face

* G. A. Soper, "The Curious Case of Typhoid Mary," *Bulletin of the New York Academy of Medicine*, Vol. 15, p. 698, 1939.

her again; he made other arrangements. Early the next day Dr. Josephine Baker, three policemen and an ambulance descended upon the brownstone mansion on Park Avenue. The carving fork was brushed aside. Said Dr. Baker, "She fought and struggled and cursed; the ride down to the hospital was quite a wild one."

Now Mary Mallon stood trial, not in a court of law, but in a locked room at Willard Parker Hospital. There she awaited the verdict. The germs of typhoid were her accusers, allegedly alive and virulent within her body, allegedly expelled by her body functions to spread disease wherever she went. The hospital bacteriologists were her jurors. Overnight in the test tubes and culture dishes of the bacteriology laboratory, the germs deliberated, grew in size and were clearly visible on the culture nutrient the next morning, the germs derived from those that the day before had inhabited the body of Mary Mallon. The verdict was guilty as charged; there was no court of appeal. The sentence was restraint, imprisonment.

Mary Mallon denied her guilt, she demanded her freedom, she struggled and wept. She appealed to the law. Surely there was no precedent to condone the imprisonment of one who had committed no crime. But the fear of typhoid fever overruled writs and briefs and legal argument, and the court dared not release a person who could spread illness and death by a wave of the hand.

In a small bungalow on the grounds of the Riverside Hospital, Mary Mallon was "detained." Everything possible was done for her comfort; only her liberty was denied. There she remained for three years. She seemed to become progressively subdued. It seemed that the repeated accusations had finally reached her, had finally convinced her that she was indeed a menace, a potential killer of her fellow humans. She promised to change her vocation to something other than the handling of food, pledged to report regularly to the hospital for examination. So she was released and Mary Mallon disappeared for five years.

Little is known of her life during these five years, except that she changed her name and worked for a time in a laundry, then returned to cooking. Typhoid fever continued to erupt sporadically. Two cases were recorded in New Jersey and one case in New York, each reported in conjunction with a cook whose name was not Mary Mallon but whose description fitted her, and who disappeared shortly after typhoid appeared in the household.

In 1915, Dr. Soper was called to render professional and expert services. The Sloane Hospital for Women had twenty typhoid patients in their beds; they had come to the hospital to

be treated for other ailments and one by one they had contracted typhoid fever. The diagnosis was unmistakable, the germs had been identified in each case, and the hospital staff could not understand how the germs had invaded through the barriers of scrupulous sanitation. Dr. Soper asked to see the cook, and, though the cook's name was not Mary Mallon, once again he met Mary Mallon.

This time there was no disturbance as Mary Mallon was led back to the cottage on the grounds of the Riverside Hospital which she had left five years before. She did not struggle or weep; her misfortune had humbled her proud spirit.

For twenty-three years she remained quietly at the hospital as a "guest" of the city of New York. There she did a little work, but no cooking, and she was paid well. It was evident from the beginning of her second stay that she was truly subdued, and as the years passed she spoke less, and had little to do with those about her. The hospital authorities said she might visit her friends, but only for a day, and she did so only once and returned early, and no longer asked to leave the cottage. It was learned later that her friends had received her coldly, for she was no longer an anonymous cook. The silent germs of typhoid fever had shouted her name over all the world; Mary Mallon had become an infamous personage. Thereafter she remained secluded becoming progressively more withdrawn and morose.

As the years went by, her misfortune gnawed at her mind; she brooded by day and slept little at night. One morning she was found lying inert on the floor beside her bed, unconscious from a paralytic stroke. The last six years of her life passed in dreary silence, as she lay totally paralysed. For thirty years the persistent germs of typhoid fever that brought merely illness or merciful death to others had brought to her years of bitterness and agony of spirit. She died in 1938, and the restless germs that had lived so prolifically within her body troubled her no more. The persistent germs of Mary Mallon were laid to rest with her body, their persistence terminated only in the finality of her death.

It was all painful and sordid, yet Mary Mallon's carving fork stood as a symbol of self-respect, of struggle for human right to life and the pursuit of happiness. For she had been in her right, and Dr. Soper had been in his right, and the health authorities, the hospital staff and the magistrate who had denied her liberty all had been in their right. It was simply that she had met misfortune—the typhoid carriers that came after her were neither humiliated nor denied the right to live—she had met misfortune, like Noguchui and Thuillier and her other

fellow martyrs. Perhaps she felt more unfortunate than they for she had not gone out seeking the wild germs of death as they had; the germs of typhoid fever had sought her out and destroyed her.

Through the ordeal of Mary Mallon, the fundamental secret of the persistent germs of typhoid fever was uncovered. The germs are easily destroyed, by mild disinfectants, by sunlight, by hot water; in sewage they live weeks or months; in sealed test tube cultures they have been known to survive for thirteen years! In a suitable healthy human body they can live a human lifetime, a million germ lifetimes! Healthy human test tubes nurture the germs, and as long as the human test tube lives the germs also will live. As the human test tubes proceeded in their routine of human existence their body functions release some of the germs periodically, and every carrier bears within him the seeds of a typhoid epidemic.

Now the search for typhoid carriers began and many were found. Inspired by Dr. Soper, the typhoid-carrier hunters roamed everywhere, anywhere that typhoid fever had been. And typhoid carriers were found everywhere; no stratum of society was free of them. Take any thousand healthy people at random, subject them to gross invasion of their privacy, seek for germs in their bodies and at least one in every thousand will be found guilty of harbouring virulent germs of typhoid fever!

Once there was a hermit who lived on the crest of a hill and who desired nothing more than to be left alone, but he was denied that privilege. His outdoor privy was contaminated and spilled typhoid fever into the wells of non-hermits living in the valley at the bottom of the hill. The typhoid-carrier hunters found his secluded privy, braved the rain of typhoid-laden excrement with which the hermit greeted their intrusion, and ended his seclusion and the periodic outbreaks of typhoid fever in the valley.

Then there was a cheerful waitress who served orange juice and typhoid germs to her customers for many years, before the hunters found and restrained her. There was a fond grandmother who had knowingly carried germs of typhoid fever for thirteen years, but who could not resist a visit to her newly-born grandchild, to whom she unhappily presented virulent typhoid fever. And there were those two remarkable carriers who had been spreading typhoid fever, one for forty-six years, the other for fifty-two years. Another carrier was renowned less for the many years throughout which she had spread the disease than for the four thousand separate cases which had been traced directly to her.

H.O. was a conscience-stricken carrier; he had caused thirty known epidemics and five deaths. He consented to the removal by surgery of his healthy gall bladder where it was believed the germs multiplied. The operation was successful and the healing was routine, but the typhoid experts were wrong; H.O. remained a carrier and, minus his gall bladder, continued to spread typhoid fever.

Most unusual of all the typhoid carriers was J.S., a native waiter in South Africa. He was a person of distinction, although it was a distinction for which he had little regard. His body sheltered a unique variety of typhoid germs, a variety that could not be found anywhere else among all the millions of people in the world, only in J.S.'s body. Though the germs were extraordinary, the typhoid fever they brought was the common deadly variety and J.S. left a trail of sickness and death as he migrated from job to job. He became skilful in escaping and evading the hunters of typhoid carriers, but he could not conceal the trail left by his unique germs. He started epidemics and his germs betrayed him, giving a singular blood reaction in each of his victims. Like a fingerprint, the germs of J.S. were identified by the bacteriologists in each victim as readily as if his name had been written on each and every one. When the hunters would find J.S.'s germs in the body of a typhoid patient, they would look for and find J.S., and though he escaped again and again they always caught him, until J.S. in despair gave up his defiance and submitted to restraint.

Many drugs and many methods have been tried in vain attempts to eliminate the germs within typhoid carriers. Vaccines have been used, miracle drugs and other drugs less miraculous, iodine, arsenic, salicylates, thymol even charcoal and chloroform, all without success. Carriers remain carriers; the germs continue to multiply in selected human bodies. In the state of New York, 2,500 typhoid fever carriers are known and an unknown number remain undetected. In the city of New York, 350 carriers must report four times each year to the department of health and notify the department when they leave the city in order that the health departments in the cities of their destination may be warned; they must report or risk the fate of Mary Mallon.

This had been the history of the germs of typhoid fever, which had their beginnings somewhere in the remote past. The history is not ended; it has merely changed from a problem in medical science into a sociolegal puzzle, the rights of individual humans versus those of humanity *en masse*. The germs of typhoid fever, hidden in the most secure of shelters in the

deep interior of healthy human bodies, defy physicians and drugs. They are kept checked in a precarious balance by sanitary engineering, but the balance may be upset easily, by war, flood, fire or earthquake. The germs of typhoid fever await human disaster to unleash their disease to add the horrors of pestilence to human catastrophe.

CHAPTER XII

THE PERSISTENT GERMS

RECORDS OF history have shown that while the achievements of the germs of dysentery are profound, they lack the spectacular flair of more deadly plagues. There are no great explosive epidemics, no immense waves of pestilence engulfing nations and continents; germs of dysentery never invade the inner recesses of the human body as do the germs of typhoid, nor can they match the swift death of cholera. Dysentery is a commonplace ailment. The germs do not always kill men, but they invariably embarrass and incapacitate them. In every age and in every human activity, nothing is more embarrassing and incapacitating than "griping in the guts."

In early times, germs of dysentery aided by germs of plague routed the Persian hordes that Xerxes I had assembled to march against Greece. Centuries passed, men continued to live with dysentery, and new generations of men and germs arose. In the age of the Crusades the germs again became prominent, when army upon army advanced against the Saracens, only to melt away before they could encounter the enemy. There were many pestilences among the Crusaders, yet dysentery was most destructive. The germs were far more effective than the waving of banners, the slashing of swords and the thrusting of spears. They were more formidable than any of the Saracens. As it marched to the east each crusading army in turn disintegrated when the germs of dysentery spread among them.

The army of Albrecht, the German emperor, managed to reach Baghdad and deployed before the city walls. The Saracens unsheathed their swords and pointed their lances, the flaming oil and the boiling pitch were readied, the catapults were sprung—but they were never used. Dysentery had entered the camps of

the besiegers; the imperial army retreated and made for its homeland in disorganised rout, carrying with them their dead emperor and leaving the battleground strewn with discarded German arms and trappings.

All France lay helpless before Henry V when the English defeated the French Army at Agincourt. He might have added to Britain's realm and linked France to England, Scotland, Ireland and Wales. Instead, he parleyed. He had little choice; a troop of French peasants armed with pitchforks could easily have disposed of his army, for dysentery had infiltrated into its ranks.

In 1740, Frederick the Great of Prussia met the army of Maria Theresa of Austria. It was a brilliant triumph for the emperor, yet his men painfully retreated in disorder with germs of dysentery harassing the dispirited Prussians.

A few decades later, the French Revolution arose and was opposed by the armies of Prussia and of Austria. History relates that the Revolution was the victor, its enemies attacked and dispersed not by Frenchmen and the red flag of revolution but by germs of dysentery.

Three quarters of a century passed, and Frenchmen and Germans again clashed. Now the germs of dysentery favoured the Germans. The French Army suffered severely and many of the soldiers of France paid small heed to their German enemies; the French dysentery was more deadly. One sixth of their number met death, destroyed by dysentery, their bodies untouched by shot and steel.

France in 1889 had no war, but the troops of the Châlons Military Camp were put to rout. The germs of dysentery were the attackers, the disease breaking out in the camp and persisting despite every effort of the medical corps. The army yielded and the camp was abandoned. A year later, tents were again pitched on the Châlons Military Camp site where dysentery had been victorious, and the germs emerged from the contaminated soil and again routed the French army.

Across the ocean Civil War had raged in America for four years. Dysentery penetrated into the armies of the North; nearly every man in blue was reached by the germs, and of every ten sick men, one died. The exact record of the germs of dysentery in the armies of the South is unknown, but it is certain that there the germs were even more disastrous.

The Crimean War, the Russo-Turkish, the Russo-Japanese, the Boer, all had well-laid plans for swift victory that turned into stalemate and defeat because of dysentery.

Years passed, nations changed sides as wars continued, and dysentery continued to interfere with the strategies and tactics

of staff generals and admirals. During World War I the British were checked in Gallipoli less by the Turks than by the germs of dysentery, one third of their army ineffectual and uninterested in feats of arms because of dysentery. The British fared no better in East Africa; again one third of their men because of dysentery were disinclined to march, advance or retreat, unable even to hold a rifle.

Dysentery interfered with the smooth military precision of World War II. The British, German and Japanese armies in Burma all suffered from dysentery; the British were favoured, their germs being milder. Zinsser's *Textbook of Bacteriology* dims the brilliance of the victory at El Alamein by suggesting that Montgomery had received unforeseen aid from the germs of dysentery that attacked the Germans and Italians.

The United States discovered more about dysentery during World War II. Though equipped with the ultimate in medical and sanitary safeguards, the American Navy at Leyte and later at Tokyo Bay was harassed by epidemics of dysentery, small outbreaks that continued to erupt on board ship and ashore despite every means of control known to science.

When dysentery was recorded among civilians, it was noted as outbursts rather than epidemics. The germs had brought pain unchronicled to the men of the Stone Age and to their ancestors, and when history began to be recorded dysentery was treated lightly as a personal and trivial misfortune like breaking a leg or losing a bet, or a tooth, or a wife. It has remained so until very recent times. It was physician Smith in the nineteenth century who wrote of dysentery and propounded cheerily that "dysentery is a disease of autumn," the "fever of the season turned upon the bowels."

Records of dysentery epidemics among the civilian population of Europe began to be noted in 1538, and they continued over the years. In the seventeenth century, the "fluxes" of dysentery were widespread. An unusually violent outbreak in London in 1636 was responsible for an additional heading in the bills of mortality for that year: to deaths from "plague in the guts" was added "rising of the stomach."

In 1758, dysentery again raged in England; "bloody flux carried off not only many of the common people but also several persons of high ranks." A few years later dysentery returned; "it laid heavily upon the children and was attended with a very ardent fever." In later years reports of dysentery epidemics became fewer, as they had become so commonplace that there was no need to report them.

The perpetuation of the germs of dysentery has always been

aided by human filth and filthy humans, and these were ample in early times. The water closet had been invented in 1596, but it was regarded as a curiosity and remained such until late in the nineteenth century. In many of the great public buildings of Europe, in Paris, Florence, Rome, Venice and Cologne, in the Versailles palace, the great architectural masterpieces of Christopher Wren and others of the classical period, there were no provisions for "relief of the bowels." And not until the beginning of the twentieth century was a distinction drawn between laying pipes for water and laying pipes for sewage, nor was it realised that rivers could not satisfactorily serve for both the disposing of wastes and the supplying of water, and that there was a need for removal of filth from the streets and alleys of towns and cities.

Many centuries before, Hippocrates had described dysentery. He had noted how it differed from other disorders, that it was sometimes mild and sometimes deadly, that in some victims it would eventually end but in others continue for a lifetime. Twenty-five centuries elapsed and nothing was added to what Hippocrates had observed. Then the era of the science of germs arrived; it was the golden age of bacteriology, a time of enthusiasms and pioneering, and every day new species and varieties of germs and diseases were discovered. Among the scientist-pioneers there were some, though not many, who searched for the species of germs that causes dysentery.

It was an incredibly difficult search. It was less like looking for a unique leaf in a forest than like hoping to find one pine needle unlike any of the others in a primeval wilderness of evergreens. In the human intestine are myriads of germs, hundreds of genera, species and varieties. Which among these are the germs of dysentery? Where could men be found to search for the hidden germs of dysentery, to work with confusion and pain and disease, surrounded by odours of filth and death?

For every human problem, however unpleasant, it has been the good fortune of mankind that men are always found who willingly undertake its study.

There was such a man in Russia. Dr. von F. Lösch probed among the jungle of alien beings that live in the human intestine and discovered the parasites that cause one kind of dysentery. Technically they are not germs but animals. They are very small and very violent, voracious amebae that gnaw holes in the living flesh of men and entrench themselves, and they cannot be dislodged by any means known to medical science. Lösch found that this kind of dysentery is a disease that once begun has no end. It persists for a human lifetime, causing misery but rarely

death. He found no remedy for dysentery, but he separated chronic dysentery caused by the amebae from acute dysentery caused by germs.

A few years later, another man was found, and he looked for the germs that brought pain and death to his countrymen. In Japan, as in Europe, there was always dysentery. It was a special kind of dysentery, much more deadly than the European variety. Each year during the summer season, year after year, the Japanese suffered the agony of Oriental dysentery, many thousands caught the disease, and always at least one-fourth of them became paralysed and died.

In Japan, Dr. Kiyoshi Shiga began a patient search for the unique pine needle in the pine forest even though he knew that many others had tried and failed. Shiga persisted with hundreds of cultures, with thousands of germs isolates, with innumerable animal tests—the years seemed to hurry past as he worked—but none was the authentic germ of dysentery. He was the most patient of men, but even the greatest store of patience has its end—the task seemed impossible. Then Shiga asked for advice from another patient searcher, Dr. Kitasato, who had been the first man to see the deadly germs of bubonic plague. And it is related that Kitasato said to Shiga, “Let the blood of the human body point out the germs of dysentery.”

Shiga did so. He allowed the profound chemistry of human protoplasm to do as nature had intended, to ignore the multitudes of spurious pine needles and detect unerringly the germs of dysentery. In the blood of patients who have been infected with dysentery are antibodies that cause the germs of dysentery to clump together in dense masses. The antibodies of dysentery do this to the germs of dysentery and to no other germs. Shiga mixed each of his germ cultures with blood from dysentery patients, and among them he found one culture that clumped together in dense masses! And by this means he found the germs of dysentery. That was in 1898, and the germs became known as *Shigella dysenteriae*, the dysentery germs of Shiga.

It might have been a pleasant ending to a tedious search, but it was not the end.

Now other bacteriologists followed after Shiga, for dysentery was abundant, the supply of germs excessive and dysentery patients always available. Many of the germs of dysentery were isolated, germs from the Philippines, Germany, the Netherlands, Rumania, France, Ceylon, England from every part of the world. Each was compared with the original Shiga culture and confusion suddenly replaced the satisfaction that had greeted the brilliant solution to a nearly impossible problem! The newly

isolated germs of dysentery from various lands resembled Shiga's germs and each other, but they were not identical with Shiga's germs or with each other!

In the present era of bacteriology, the confusion has not been erased; it has merely been classified. It is now acknowledged that the germs of dysentery are flexible and versatile, existing in many forms. At first, as each new form was discovered, they were named after their discoverers: the germs of Shiga, Kruse, Flexner, Hiss and Russell, Gray, Wollstein, Strong and Musgrave. In time, this nomenclature proved inadequate; there were more kinds of dysentery germs than there were famous bacteriologists to study them. Now they are known by unscientific designation as the dysentery germs of "Manila" and "Utrecht," as "Tuckahoe," "Baltimore," "Seal Harbour," "New York," and many others, with still others remaining to be discovered.

In this our modern times, nearly a century has passed since the dawn of the age of bacteriology, but the germs of dysentery still persist. The germs brought a painful illness to the men of the Stone Age, and the lineal descendants of those germs bring the same painful illness to modern men. The germs still elude and confound the scientists who study them.

Recently they learned how the motion of a little finger can bring illness and death.

The cheerful proprietress of a small sweets shop in London poured four pounds of dried split peas into a large saucepan, added water and put the pan on the stove. For three hours the peas and water boiled and simmered. Then she removed the pan from the direct flame and for the following two days she kept it near the stove at a lukewarm temperature. From time to time, she added a little hot water and stirred it to keep the contents of the pan smooth and appealing to the eye. This was "pease pudding" and the proprietress of the sweets shop sold it in small portions to the people in the neighbourhood.

The next day, thirteen of the customers complained of agonising pains, became violently ill and collapsed into unconsciousness. Of the thirteen, five were adults and they all recovered eventually, but eight were children—dysentery is more dangerous to the young—and two of them did not recover.

Then the experts, the physicians and the epidemiologists, entered the case. Thirteen infections with virulent dysentery, all in the same neighbourhood, soon led to a common factor—the pease pudding in that sweets shop in London.

The unhappy proprietress wept as she showed them how she had cooked the dried peas. For many years she had made the

same pudding and no one had ever suffered from it. The peas were of the best quality; her shop and her person were always fresh and clean; how could she have brought illness and death to her neighbours?

And the experts were impressed, and they wavered. Perhaps there was some other common factor? But they took the remnants of the pease pudding to the laboratory, and the laboratory men reported virulent germs of dysentery growing luxuriantly in the pease porridge!

How had the germs become implanted in the pudding? It was neither from the dried peas nor from the water—boiling for three hours will kill any variety of germs of dysentery. Did the germs drop into the pudding from the air? Positively not, said the experts; germs of dysentery rarely if ever float in the atmosphere. There must be a source of infection somewhere, said the experts.

So they returned to the sweets shop and the questioning resumed. The experts were patient and courteous but persistent. They learned that, in addition to the customers, a little girl had visited the shop and had spent several hours there. So they questioned the little girl. Yes, she had sampled most of the wares in the shop, a nibble here and a nibble there, and she also had sampled the pudding soon after it had cooled—she had scooped out some pudding with her little finger!

She was rather a slovenly girl, but that really mattered very little. The experts found that she was a dysentery carrier. Even the neatest of little girls who are dysentery carriers are liable to carry virulent germs of dysentery on any of their fingers. To spread dysentery, only a few, even a single germ is sufficient!

Vaccines and serums for dysentery have been tried repeatedly, and they have proved valueless. The miracle drugs have some value; they destroy the germs, but their use invites danger. Though the germs are destroyed by sulphonamides and streptomycin, a few always survive, and these few become resistant. Then a few become many and they begin dysentery again, a dysentery that is now resistant to miracle drugs.

It is known that dysentery is most deadly to infants, and modern science can do no more than attempt to shield them from the germs. Not modern miracle drugs but an ancient nostrum, sour milk, is recommended as the best means of preventing dysentery in the very young.

Epidemics of dysentery have become fewer recently but the germs exist and perpetuate themselves as they always have. They live exclusively on humans, on those that are ill with

dysentery and in the human carrier. Dysentery is far more prevalent than typhoid fever. There are more carriers and there is no known medical method for eliminating the germs from the carriers and no legal method to restrain them and the dysentery they disseminate.

The place of the origin of dysentery remains unknown. The date of origin is more certain, although it cannot be marked, for men probably suffered from bellyaches shortly after they developed bellies. And when men reach for the lands beyond the planet Earth, they will most likely carry with them the germs of dysentery and bring "griping in the guts" to the stars.

CHAPTER XIII

THE INTANGIBLE GERMS OF PARALYSIS AND CONTROVERSY

THE ANCIENT germs of poliomyelitis are skilful parasites, and they have lived unnoticed in men for many thousands of years. They need human nerves and human brain tissue for their survival. No other animal is suitable. In the laboratory the germs infect monkeys and mice and cotton rats by the artificial experiments of scientists but not by the choice of nature.

The germs and their disease existed unrecognised for many years, leaving a long trail in time marked faintly by shrivelled limbs and twisted bodies. Only the artists, aware of all things about them, kept a few scanty records on plaster walls, wooden panels and canvas. An Egyptian artist who lived in 1580 B.C. painted a religious procession as it marched to the temple of Astarte in Memphis. His painting has survived the blight of time, and today it reveals that, though he worked in the formal tradition of the Egyptian school, he was an unflattering realist. His full-length figure of Ruma, priest of the temple of Astarte, shows that Ruma walked on a muscular right leg and limped on a shrivelled left leg, with his ceremonial staff gripped between his arm and shoulder in the manner of a crutch, instead of extended before him in solemn ritual.

Many centuries later, Hieronymus Bosch and Pieter Brueghel the Younger painted other cripples who walked with the characteristic stigma of poliomyelitis.

As the years passed, the germs continued to maim and kill and live the mode of life designed for them by nature. Among the Norsemen of the civilisation that thrived briefly in Greenland during the fifteenth century, there are no written accounts of poliomyelitis. Yet, scattered among their remains, some skeletons were found with the withered leg bones that are the hall-mark of the germs. Throughout Europe poliomyelitis existed but aroused little alarm, for, unlike the other pestilences of the Dark Ages, the disease was not remarkable for swift deadliness or widespread epidemic outbursts. Medieval poliomyelitis struck singly and seemingly at random in homes widely separated from one another. It never attacked adults; its victims were always children.

The medieval physicians and those of later eras did not understand the illness and paralysis they were called upon to heal, but they were undismayed by that which they did not comprehend. They blamed the carelessness of nurses, or the evil eye, or poisoned milk, or atmospheric influences and cheerfully prescribed calomel and "two or three brisk purges," and electricity or strychnine, with "blisters to the spine and cataplasms to the affected limb." They deplored "the sad state of people who are now adults, who still drag one weak leg because they were not treated in time."

The years passed by in decades and centuries. The germs of poliomyelitis reproducing themselves and perpetuating their species, left the age of feudalism along with men and moved forward into the modern era. The nineteenth century arrived and flourished and still there was no change in the customary behaviour of the germs. They continued to invade in single forays, to select certain children and to bring them fever and illness, sometimes leaving behind a healthy happy child, at other times one that limped and lived incompletely, and occasionally a child that no longer lived at all.

The nineteenth century had almost run its course when the *change* began. Imperceptibly, instead of single victims, the germs of poliomyelitis attacked by two and threes, then by dozens, and whole neighbourhoods became fearful as their children became feverish and paralysed. Towards the end of the nineteenth century, poliomyelitis changed from an unimportant and non-epidemic disease into a major pestilence! While other pestilences had declined as modern days approached, poliomyelitis had increased! It forced itself upon the notice of the physicians, who were compelled to regard it as a distinct disease; they called it the "temporary paralysis of early life." A few years later, when it became clear that the paralysis was not always temporary, the

name was altered to "morning paralysis," and still later to "essential infantile paralysis." The change continued and as the disease entered a new phase the name "infantile paralysis" became a misnomer. Now the germs no longer attacked only children, but adults also became ill, and among them the infection was more deadly!

For the first time in their long history, the germs became openly contagious. There was an epidemic of poliomyelitis in 1887 over all of Europe. The ailment of fever and paralysis and death spread from victim to victim and from place to place like other more familiar germ diseases.

The twentieth century began with the germs of poliomyelitis bursting out everywhere, in Australia and Austria, in Germany and France, in Switzerland and Russia. The disease toll was counted by hundreds, then by thousands, the numbers increasing in one year, decreasing in the next, only to increase again the following year as the germs entered upon a rhythm of epidemic eruption. In Norway and Sweden the epidemic was widespread and deadly among both children and adults; many died and many survived to limp on shrivelled limbs. As the toll of death and paralysis increased, there were fewer physicians who adhered to the belief that poliomyelitis was an "internal morbidity." By 1905, all agreed that poliomyelitis was contagious and caused by a germ infection, even though the germs themselves remained to be discovered.

Death and paralysis in Norway and Sweden had subsided in 1906, but in the next year, when thousands of Scandinavians began to migrate to America, the germs of poliomyelitis came with them to ignite the first great epidemic in the American Midwest. Since then epidemics have erupted everywhere, with thousands infected, thousands paralysed, and thousands dying. Poliomyelitis epidemics are commonplace today; almost yearly now the epidemic wave returns to many parts of the world.

The year 1887 marked a great turning point in the history of the germs of poliomyelitis, for it was in that year that the first epidemic of poliomyelitis occurred. And with the epidemic had come the second innovation—now the germs of "infantile paralysis" attacked older children and adults. Yet the ancient germs of poliomyelitis and their disease had not changed.

There is an answer to the riddle, a simple but perplexing answer. Epidemics of poliomyelitis take place *only where the habits of western civilisation exist and where standards of living are high*. It was not the germs that had changed, but man. Man had modified his habits and so brought upon himself the epi-

demical form of poliomyelitis that had not existed in earlier and less civilised times.

In primitive lands, as in many parts of the Orient today, the germs abound in contaminated food and milk, in dirty clothing and frowsy bedding. Poliomyelitis is everywhere, yet everyone is free of the disease. Everyone has been exposed to its infection since the day of birth and so is immune. Infants born into filth and squalor do not suffer from poliomyelitis when the germs invade. They are protected by the antibodies supplied by their mother during pregnancy. The protection is temporary, lasting only for a few months after birth, but it is sufficient. The infants are certain to be infected repeatedly, but soon they form their own antibodies and build their own immunity. As infants and later as children, they become infected and reinfected as they come into almost continuous contact with the germs in the filth that surrounds them. The infections are trivial and with each infection they become ever more immune to poliomyelitis. When they have become adults, they are solidly, immune, however virulent the germs, however massive their invasion. Nature had set up an ecological balance between germs and men whereby both survive.

By introducing cleanliness, Western civilisation upset this ecological balance between men and the germs of poliomyelitis. Hygiene and sanitation are innovations unforeseen by nature and they have changed a benign disease into a dreaded pestilence. Epidemic poliomyelitis, the product of civilised living, becomes ever more severe and widespread as the custom of civilised living increases.

For many years before 1887, poliomyelitis had been increasing, as street cleaning and plumbing slowly changed from curiosities to luxuries to commonplace necessities. When germ life became recognised as a cause of disease in 1850, terror from the invisibly small hostile life that surrounds men accelerated the application of the principles of hygiene and sanitation that culminated in the poliomyelitis epidemic of 1887.

Since then there have been ever-increasing cleanliness and poliomyelitis. For innumerable centuries, the germs had been travelling from host to host to encounter resistance and immunity, only rarely meeting a susceptible child. Now in civilised areas children are born in antiseptic hospitals, surrounded by surgical masks and sterilisers, their food and drink free of all forms of germ life. From these immaculate hospitals come children born and reared under glass, and, when they enter into life outside the hospital and encounter germs of poliomyelitis, they are defenceless. As the germs become fewer, they become more

deadly. They invade children and meet no protective antibodies in their blood. They invade adults who never having been exposed to poliomyelitis can offer no resistance. Then the germs, unrestrained, pass from victim to victim, gaining momentum in virulence and contagion, and an epidemic of poliomyelitis rages, leaving paralysis and death behind.

Each decade, poliomyelitis becomes more severe and widespread. The epidemics zigzag up and down as one year follows another, but their over-all trend is upward. And the future promises, unless our science intervenes, that poliomyelitis will become more and more deadly, as mothers who never had poliomyelitis give birth to infants without protection from the maternal antibodies, infant and mother both equally susceptible to paralysis and death.

The relationship between men and the germs of poliomyelitis has been upset, but the balance cannot be restored by a return to the past. Cleanliness, hygiene and sanitation were instituted by fear of germs and disease, and they are now accepted as an essential mode of civilised life. They cannot be abandoned, for, apart from their æsthetic appeal, they have saved too many lives from other diseases. There is an alternative that is free of atavism and degradation. The science of civilisation must study the disease of poliomyelitis and the germs that cause it and learn how to prevent the disease without recourse to filth and contamination.

It was learned that poliomyelitis is less virulent during an epidemic and more deadly in the sporadic infections that appear when there is no epidemic. In summer the germs are more deadly than in autumn and in autumn they are more deadly than in winter, but what all this means our science has no idea.

The epidemic waves roll over the North Temperate Zone from August to October in the northern part and from July to August in the south. In Australia and New Zealand the epidemic begins in February and ends in March, while in the tropics there is no season, poliomyelitis attacking at any time. In some years, the infections are so mild that only by blood tests can it be proved that poliomyelitis has infected many people. In other years, no blood tests are required; paralysis and death are abundant proof.

The shape and size of the germs of poliomyelitis have been observed. They are known as "small" viruses and through the electron microscope they may be seen as a mass of spheres or as bits of string. There are three types of poliomyelitis germs—the Lansing, Brunhilde and Leon strains—and, though each causes the same kind of disease with the same paralysis and

death, they differ within their protoplasm; each confers its own non-transferable immunity. When a victim has recovered from poliomyelitis caused by the Lansing germs, he is immune thenceforth to Lansing, but remains susceptible to Brunhilde and to Leon. Poliomyelitis may strike at one victim three times, once by each of the three germ types.

It is known that strenuous physical exertion during the course of a poliomyelitis attack arouses aggravated symptoms and leads to increased paralysis and death. It has been noted that the germs enter more readily through injured nerves, and physicians advise that removal of tonsils and tooth extractions be postponed during epidemic periods. It has been observed that pregnancy increases the hazard of poliomyelitis for the mother-to-be. If vaccination against diphtheria or whooping cough is given one month or less before infection with poliomyelitis, the vaccinated arm or leg will of a certainty become paralysed. Good health is no protection; sturdy well-fed children are more susceptible than the sickly and undernourished. These observations, practical rule-of-thumb guides, are useful, but their exact meaning is unknown. They are problems for science to solve in the future.

For over a century, scientists have searched for the method by which the germs of poliomyelitis spread their infection. First it was believed that infection was caused by inhaling droplets of contaminated moisture, that the germs lodged on the inner lining of the nose, invaded the olfactory nerve endings and travelled up the olfactory nerves to the brain. Then it was "proved" that, if zinc sulphate or similar drugs were sprayed into the nostrils, they would form a barrier to germ invasion and the virus of poliomyelitis would be unable to enter. In accordance with this discovery, an intensive campaign of nose spraying among children followed, but shortly after they had begun, the nose sprayings were hurriedly stopped. Newer research had found that the nasal membranes, far from being an attractive hostelry for germs to alight and enter, were the best protection that the human body had against them. It was discovered that if the nasal membranes were healthy, the germs could not possibly invade; they would invade and lodge only if the membranes were destroyed in some manner, such as by zinc sulphate or similar drugs!

It also was "proved conclusively" that flies carried the germs of poliomyelitis, but later research has thrown doubt on the fly theory. At one time or other, it has been "proved" that the germs were spread by roaches or lice or bedbugs, by rats, air currents and dust, and through milk and water. Poliomyelitis has been several times described as "linked" with genes for in-

herited hair and eye colour and blood group, and each time the "link" has been disproved. As yet poliomyelitis has not been connected with the prominences on the head or the lines of the palm of the hand, but it may be at any time.

From the results of recent research, it is now fairly certain that the germs are carried by contaminated material and invade through the mouth. They enter the throat and migrate into the blood stream, then into the nerves and the brain. Germs of poliomyelitis are found abundantly in the mouth and throat, in the intestine and in the body wastes of poliomyelitis victims, and they abound in sewage in areas where poliomyelitis is epidemic.

The search for the method by which the germs spread among men is nearly completed. The search for the prevention of poliomyelitis continues, and when it will succeed no one can say. it *must* succeed, for the germs become more violent and more widespread as the years pass.

Shortly after poliomyelitis was recognised as a disease, it was observed that those who lived through it were immune for the remainder of their lifetime.* Apparently antibodies that kill the germs were circulating in the blood of survivors. It seemed simple and obvious that the blood from survivors should protect others against poliomyelitis. It is difficult for men to learn that nature is never simple or obvious, and blood from poliomyelitis survivors has been used by physicians again and again, injected into children and adults when poliomyelitis threatened, though there never has been the slightest evidence that it gave protection against infection.

Today gamma globulin is used for temporary protection against poliomyelitis. It is claimed that gamma globulin when injected can protect against infection for five weeks, but these conclusions have been challenged, and many authorities claim that gamma globulin is worthless. So the tests and the controversies continue.

The greatest search in the history of bacteriology has been the search for a vaccine that can protect against poliomyelitis for a lifetime. The germs themselves hold within their protoplasm the secret of a successful vaccine. When injected, they can impart immunity against poliomyelitis—except for certain complications. If the germs are alive and virulent, they give ample immunity, but they may also give paralysis and death. If the germs are dead, there is no risk but there may be also no immunity. That is the problem, how to kill yet not inactivate the

* We now know that there are three types of germs and, correspondingly, three types of immunity, but ordinarily there is little chance of being infected with two or all three types.

germs, how to be certain that they are sufficiently intact to simulate the production of protective antibodies, yet dead enough to be harmless. Many vaccines have been made, tested and abandoned; they either killed and paralysed or they failed to protect against poliomyelitis. Many scientists have worked to achieve the correct balance between germ life and death. They inactivated the germs by cold and by heat, by drying and drowning, by ultra-violet rays and by electron bombardment, they used carbolic acid and glycerine, chloroform and tannic acid, and the delicate balance eluded them. They would inject the "treated" germs into monkeys, and the monkeys would either become paralysed and die of poliomyelitis or receive no immunity.

Two decades ago, Drs. Kolmer and Rule treated the germs of poliomyelitis with a soap made from castor oil. They injected the treated germs into monkeys and found that the germs had become harmless and no longer caused disease; the injected monkeys had been made immune to the most virulent germs of poliomyelitis. Kolmer and Rule then inoculated themselves, and, convinced that their vaccine was safe, they vaccinated ten thousand adults and children. Meanwhile, Drs. Brodie and Park tested another vaccine prepared by treating the germs with formaldehyde, and they vaccinated ten thousand children. Both vaccines were tested in 1935 and both tests ended in uncertainty and controversy, for poliomyelitis erupted among the vaccinated children, some were paralysed and some died. One group of experts warned that the vaccines contained some living and virulent germs, while others believed that impurities in the vaccines had aroused a deadly allergic reaction. Some authorities concluded that the vaccines were safe for further tests while others denied that they were. Finally it was agreed that the safety of the Kolmer and Brodie vaccines had best be proved, and there the controversy ended. The value of these vaccines was never investigated, for the tests were never resumed.

Recently, the Brodie vaccine has been revived in improved form as the Salk vaccine. The preliminary tests have shown that this newest vaccine is effective and safe, and vaccinations on a vast scale have begun. Will the Salk vaccinations like the Kolmer and Brodie vaccinations end in uncertainty and controversy? Or will they mark the end of the long search for immunity against poliomyelitis?

Another vaccine prepared by Dr. Koprowski contains living germs that have become adapted to life on cotton rats and have lost their virulence for humans. Dr. Sabin's vaccine also contains living germs, but they have been made to lose their virulence by excessive test-tube culture. The Koprowski and Sabin

vaccines require no injection, but are fed by mouth. When they were fed to several hundred children during 1952 and 1953, none became ill and their blood tests showed that they were immune to poliomyelitis. The tests with living-germ vaccines continue.

As vaccines are being tested and abandoned, as new and better vaccines are sought, the germs continue to cause the disease of poliomyelitis in the pattern set by nature many thousands of years ago.

The symptoms of poliomyelitis begin with a vague feeling of being "unwell," with a nose cold or a sore throat. Frequently an upset stomach precedes illness as the germs make their entry and travel from the mouth into the intestine. Soon the germs invade the blood stream, are carried to all parts of the body, and penetrate everywhere, bringing high fever and vomiting. Then acute poliomyelitis sets in, the symptoms following in sequence, and each one is more severe than the preceding. The victim becomes irritable and restless, headaches arise and seem never to end, the neck and back become stiff and paralysis begins. How far the paralysis will progress, how much it will recede and where it will end are questions that our medical science is now unable to answer. To the victim, poliomyelitis is a lottery which he enters unwillingly and from which he may emerge unscathed, or horribly paralysed and deformed, or in which he is destined to lose his life.

The illness and fever resulting from the invasion of the germs are known as the acute phase of poliomyelitis. Eventually, the germs no longer inflame and destroy, the illness and the fever end and the acute phase terminates. Then the disease is finished, the victim has recovered, but the aftermath remains.

For, after moving freely through the manifold parts of the inner human body, instinct impels the germs to seek out the inner substance of the spinal cord, to imbed themselves deeply in that part containing the anterior horn cells, to cause irritation and then to kill and disintegrate the cells. Once destroyed, these cells are gone irretrievably, for nature has made no provision for their replacement. To the anterior horn cells are attached nerves, and to the nerves, muscles. When the cells die, the nerves degenerate and the attached muscles turn into useless fleshy masses. Usually the muscles of the legs and thighs become paralysed, but other muscles may also be affected, those of the neck and chest or of the ribs and diaphragm that alternatively fill and empty the air of the lungs. When breathing ceases, then the body may continue to live in an iron lung, but there is no assurance

that the human lungs will ever breathe again without mechanical aid. This is the dreaded *respiratory paralysis*. Those who survive are grotesquely paralysed and death within a year or two awaits nearly all of them. When the germs move higher up the spinal cord to disrupt the delicate and vital nerve centres at the base of the brain, then *bulbar poliomyelitis* follows and survival is rare.

Wherever there are paralysed muscles, there will be unequal muscle pull. The soft bones of childhood are easily twisted into unnatural shapes. Adult bones are more resistant, but eventually they also must yield. Slowly and imperceptibly, day after day, the legs bend, the thighs turn, the spine tilts sideways and forward, and grotesque figures that seem to have limped out of the paintings of medieval artists are created.

In the past, there was no treatment for the deformity caused by poliomyelitis. The paralysed muscles were supported by a metal and leather contrivance fitted with laces and levers, a brace that clanked and rattled as the paralytic pulled his body awkwardly along the ground. Since braces have no power to heal, the shrivelled limbs and distorted torsos would never again be straight and firm. It had been this way for many years and there was no better way. It was necessary, said everyone, to become reconciled to the tragedy of paralysis by poliomyelitis.

One person refused to become reconciled, an obscure nurse named Elizabeth Kenny. In Australia, where she practised her profession, nurses are affectionately and officially known as "Sisters." Sister Kenny objected to the pain in the bodies of children. She could not tolerate that some children played and ran effortlessly while others crawled awkwardly encased within clumsy harness of metal and leather. Elizabeth Kenny refused to accept what they said had to be, and as she nursed the victims of poliomyelitis over many years she observed a reaction that others more skilled in the art of medicine had overlooked.

The medical textbooks taught that the germs enter the anterior horn cells of the spinal cord and destroy the cells and nerves, as a result of which the attached muscles immediately turn limp and flaccid. Nurse Kenny disagreed. Her studies had shown that the reverse happened: the muscles, instead of becoming limp and soft, contracted powerfully and painfully to their fullest extent and failed to relax at all. The paralysis came later when the contracted muscles degenerated through their inability to relax. Repeatedly, she had seen feverish bodies in hospital beds, had heard the shrieks and hopeless weeping of children in great pain. She felt carefully with trained fingers and found no limp paralysed muscles. Instead, she found muscles in agon-

ised spasm, like "swimmer's cramp" or "charley horse" but far more severe and painful, the spasm continuing unceasingly for days and weeks. She understood why the children suffered and shrieked and wept, why they twisted their limbs and bodies into contorted shapes in a vain attempt to ease the torment of painfully contracted muscles. And if a muscle remains contracted without relaxation, eventually it will be incapable of either contraction or relaxation and will become permanently paralysed. It was not paralysis of inert muscles that caused the distortions of limb and body, noted Sister Kenny, but the irritated contracted muscles that pulled steadily without relaxing and bent the pliable bones of children.

This was the simple and logical theory of Sister Elizabeth Kenny on which the Kenny method is based. If it is true, then it is also true that for many years not only had poliomyelitis been treated incorrectly but also the wrong muscles had been treated, and unfortunately in the treatment of disease two negatives do not constitute an affirmative.

To relieve the muscle spasm, Sister Kenny used hot compresses. The compresses were soft woollen cloths soaked in hot water, wrung dry and gently applied to the skin area over the muscle. The moist heat increased the blood circulation and soothed the pain, and as the compresses cooled they were replaced. Sometimes, when the muscle spasm was severe, the compresses were changed every few minutes, and sometimes the treatment was continued for many weeks. Usually within two weeks the contracted muscle relaxed, the pain ended, and as the patient rested easily, Sister Kenny would straighten the limbs and body out of the distorted position into which pain had forced them.

After the muscle spasm had been relieved, the muscles returned to their normal function, yet the child was unable to walk properly. This, said Sister Kenny, was caused by the long stay in bed, the muscles had "forgotten" how to work in harmony with other muscles. The wrong muscles tightened and the right muscles remained relaxed. Co-ordinated muscle motion can be forgotten and then co-ordination must be re-learned. Discarding the metal and leather braces, Sister Kenny devised a method of stimulating the muscles, training them to operate in smooth synchrony with other muscles. The method required practised skill, infinite patience and great love of children, for when children are ill they tire easily and lose interest and become fretful. They cannot be forced, they must be persuaded by trained persistence until muscle inco-ordination has been replaced by smooth muscle rhythm.

Then Sister Kenny noticed another difficulty. The children

were able to move their limbs and bodies, but they were unable to move them precisely where they willed. Their motions were awkward. From lack of use, control of the muscle by the brain had been partially lost; the brain had been *alienated* from the muscles. So Nurse Kenny invented another training method and the training was continued until every muscle of every body movement was being used with precision and to its fullest extent.

These were the three phases of poliomyelitis paralysis that Elizabeth Kenny named and treated: muscle spasm, muscle in-co-ordination, mental alienation.

Afterward she told of the work she had done, described her methods and discussed the results. The medical men of Australia listened and said she was mistaken. They reminded her that there was no treatment for poliomyelitis, only paralysis and braces and crutches and these were inevitable. Thereafter the medical men of Australia ignored Elizabeth Kenny and the Kenny method. She went to England and worked in the hospital wards among the feverish and tormented bodies of small children. She spoke about her work, how pain could be relieved and children could be saved from a lifetime of ugliness and despair. Among the medical men of England there was silence; they gave no indication that there ever had been an Elizabeth Kenny or a Kenny method. But she persisted. She continued to save children from pain and paralysis and to speak of poliomyelitis and her treatment even when no one would listen. Thirty years passed, but the germs of poliomyelitis did not await the outcome of the controversy. Children were carried swiftly into hospitals to pass through the ordeal of poliomyelitis, to leave slowly, to limp and halt on sad feet, to live out their lives encumbered with crutches and chained to mechanical appliances.

Today, though Elizabeth Kenny can no longer speak to explain and defend the Kenny treatment, her voice is not essential. Now it is known everywhere how she came to America and here found what she had sought—not sponsors, not special awards, not grants of money or honorary degree or executive positions, but only a fair hearing and an opportunity to demonstrate the Kenny method. It was granted in America, and the hearing and the demonstration convinced many physicians and many medical organisations.

Some still remain critical. They have accused Sister Kenny of misrepresentation, questioned the accuracy of her statistics and denied the originality of her concepts. They have maintained that muscle spasm in poliomyelitis has long been known, claiming that Jones in 1911 had used the term "mental alienation," that in 1917 Lovett had used hot compresses and had objected

to braces for the paralysed. They do not explain why the muscle spasm of poliomyelitis was not mentioned in medical textbooks. They do not explain why the discoveries of Jones and Lovett were allowed to moulder within the dusty pages of old medical journals while the germs of poliomyelitis continued to return more and more violently year after year. They have not demonstrated that the Kenny method is worthless, nor even attempted to test its value, nor ever denied the truth of the theory on which the method is based.

In some hospitals, the Kenny method has entered with a flourish through the front doors and with the official sanction of the board of governors. In others, it was admitted surreptitiously through the service door past the dustbins in the rear, and the governing staff pretend to have no official knowledge of it. In still others, the Kenny method is used but under another name or with no name at all. Some physicians advocate it, others claim that it has only a sentimental value. But the Kenny method has come to be practised wherever poliomyelitis is treated and eventually the controversy will be settled. Elizabeth Kenny and her method will be vindicated by the number of children of the future who will encounter the germs of poliomyelitis and who will walk unaided from the encounter with straight limbs and vigorous gait, to spend a lifetime unhampered by harness or crutch.

CHAPTER XIV

THE INTANGIBLE GERMS OF ENIGMA

OUR MEDICAL scientists know that influenza is caused by very small germs that have been named viruses, but they do not know when or where these germs arose or where or how they hibernate between epidemics. When our medical historians attempt to trace back the history of influenza and link the disease with the history of men, they encounter only mysteries and questions without answers.

In the fifth century before the birth of Christ the great and wise physician Hippocrates, who knew of all diseases, described an ailment that might have been influenza. But Hippocrates died and Greece fell. The practice of medicine declined and

disappeared, to be replaced by ignorance and superstition. For many centuries following Hippocrates, there was no knowledge of medicine, and there was no written record of influenza.

The centuries continued to pass and slowly the art of medicine revived as physicians began to replace charlatans. It is true that the ministrations of these early practitioners were of little value, but they observed and described and learned to recognise the diseases they were called upon to heal.

As medical knowledge grew, influenza again appeared in the chronicles of health and disease. In these early times, the chronicles were vague, and the germs of influenza seemed to weave in and out. Now they would appear here and disappear there, now they were noted in certain documents, and now they were not, now they were mentioned casually as a trivial after thought, and now as a major catastrophe. The germs were active toward the end of the sixth century, when an epidemic in the city of Tours was described. Then they apparently became dormant, as for three centuries there were no records of influenza. The germs reappeared in Europe during the ninth and again in the tenth century, but the eleventh passed by unscathed. There was influenza during the twelfth century, none in the thirteenth, but it returned again in the fourteenth. And during the fifteenth century it was reported that law courts were suspended and sermons abandoned because of the sudden outbreak of a disease resembling influenza.

At the end of the fifteenth century, a great medical enigma unfolded; the deadly English "sweating sickness" remains still an unsolved mystery.

It was a most remarkable disease. Unheralded by signs and portents, it simply appeared all at once. It began in 1485 aboard ship, among the troops of the Duke of Richmond as they were sailing toward England. Suddenly some of the men in the hold turned pale and sick. They shivered and complained of the cold, became feverish and weak and began to sweat freely all over their bodies. And then they died, some within an hour, some living for one day and dying the next; none was sick for more than a day or two. Either they died immediately or recovered quickly.

This was the Sweating Sickness. And rapidly and mysteriously it spread to every ship in Henry's fleet.

Within the confines of each ship, the soldiers watched in terror as their shipmates one after another sweated and died. They ran from the hold, crowding on to the decks, but they could not escape. The pestilence spread among them and they became sick and died on deck as did those below. Eventually

the ships made port, and the soldiers, those who were able, rushed over the side and hurried each man to his home. There they found another most amazing mystery! When the soldiers reached their homes, the Sweating Sickness awaited! Their pestilence had travelled faster than they and had reached their towns and villages before them, and they arrived to see many of their townsmen, friends and family dying.

There was another mystery—the mystery of the class of people who were most likely to be attacked by the Sweating Sickness. Usually the germs of disease prey on the over-worked and under-fed people in the slums of great cities, but not the germs of Sweating Sickness—they were more fastidious. They most frequently infected the upper and middle classes. When the Sweating Sickness reached London, the Lord Mayor, his successor and six aldermen were among the first to sweat and die. Most germs find their victims among the feeble, aged and sickly; the germs of Sweating Sickness preferred those in the prime of life and in the most robust health.

And only England suffered from Sweating Sickness! In many towns, one third of the people died. In some villages, the entire population was exterminated, and the homes and buildings, devoid of life for many years, slowly crumpled away. In Scotland and Ireland there was no Sweating Sickness at all. On the continent of Europe there was no Sweating Sickness. Only the English were hunted down and destroyed; the foreigners in England seemed to be immune—none of them became ill. And the germs relentlessly pursued the Englishmen across the Channel; in Calais, Englishmen were singled out to sweat and die while Frenchmen around them were unharmed. (Does this seem incredible? When the Eskimos on Victoria Island were dying of influenza in the epidemic of 1946, the white men among them were unaffected.)

As suddenly and as unexpectedly as it had come, the Sweating Sickness disappeared.

But the Sweating Sickness was not done with the people of England. The germs were dormant for a decade, then all at once the deadly sweating began again. It lasted for a few weeks and then rapidly dwindled and vanished. Another decade passed and the Sweat returned. Four times during the course of half a century it came and went, and then no longer returned and no more was heard of the English Sweating Sickness!

As if to add a final fillip of mystery, to tantalise the scientists and medical historians who study epidemics and who like to see events logically packaged and neatly filed, at their outburst in 1528 the germs of Sweating Sickness did what they had never

done before—they invaded the continent of Europe, bringing sweat and death to non-Englishmen!

The Sweating Sickness crossed the Channel in 1528, but there was no Sweating Sickness in France. The germs seemed to leap over French soil and into Germany. Four weeks later, the Sweat erupted in Holland. And then the germs moved on to Austria, to attack not the Austrians but their mortal enemies the Turks, who were besieging Vienna. Rapidly the Turkish ranks were thinned by sweating and death, the siege was raised, and the remnants of a great Turkish army fled in terror and disorder. But the Viennese were unharmed; even when they captured Turkish prisoners and looted the pillaged among the abandoned tents filled with the dead and dying of the Turkish hordes, they remained free of Sweating Sickness!

This was the amazing English Sweating Sickness. It had never been known before 1485 nor after 1552. It disappeared from medical history and has not returned, unless it has returned under the alias of epidemic influenza!

There was an epidemic in Europe during the year 1510. It was not called influenza but it must have been influenza because Drs. Willis and Sydenham said so. These two physicians lived and practised in the seventeenth century, and their fame has been perpetuated into the twentieth century. After Willis have been named certain nerves and a group of arteries in the brain; after Sydenham, a syndrome of quivering muscles, a certain kind of cough and a hospital. Willis and Sydenham said that the sickness of 1510 was the first genuine and official epidemic of influenza, but they gave no details of the epidemic or the disease.

Dr. Short was a physician who lived during the eighteenth century. He was not in the least famous, but he wrote about the epidemic of 1510 as well as about other influenza epidemics, and all our knowledge of the first official epidemic of influenza comes from his account. To earn his bread, he practised medicine, but his avocation was epidemics and influenza. He felt that his mission was to unfold the mysteries behind epidemic disease. So, between visits to his patients and prescribing for their ills, he pried into old medical reports and health records whenever he had the opportunity. He was a methodical man; he fussed over each document, examining them again and again to be certain that he had not overlooked something important. And here is what he found.

He showed that each of the influenza epidemics had its beginnings in the events of years previous, in omens and portents

and in signs and symbols that make the coming of pestilence inevitable. "Without these signs and omens, no epidemic can begin," said Dr. Short, "and each has its significance. If we knew the significance then we would know all there is to know about disease as well as epidemics and influenza. We would know how to prevent it and how to heal it."

The epidemic of 1510 really began four years before, wrote Dr. Short. First a comet was observed and shortly afterward Vesuvius erupted. "This is extremely significant," said Dr. Short, "for comets and volcanic activity invariably mark the beginning of great pestilences." Afterward a "murrain" infested the cattle; they sneezed and coughed, their eyes watered and some died. This was followed by an invasion of caterpillars that blighted the fields and caused privation among the lower classes. "Famine always precedes a pestilence," observed Dr. Short. The next year, blood-red rain fell from the heavens, staining clothes and even penetrating into the larder to put red spots on grain and bread. The following year, there were continued earthquakes and a volcanic eruption in Iceland, while great stones fell from the heavens, some weighing as much as 120 pounds. The final sign (and the most significant according to Dr. Short) took place in London. There a storm came up suddenly from a cloudless sky and continued for several days; the wind grew so violent that "it blew down an eagle of brass from Paule's Church and in the falling, the same eagle broke another eagle set up at a tavern door in Cheapside." Then the epidemic of 1510 began.

It was not then known by the name of influenza. In France it was known as *la grippe*. And in England Dr. Short wrote: "The disease called *Coccoluche*, or *Coccolucio* (because the sick wore a cap or covering all over their heads), came from the island Melite in Africa, into Sicily. It attacked at once, and raged all over Europe, not missing a family, and scarce a person. Where blood was let, the disease proved malignant and pestilential, being attended with a violent cruel, and unheard of malignity, and made bad work."

The momentous influenza epidemic of 1510 finally ended. Dr. Short concluded his account of its ravages as follows: "None died, except some children."

None died, except some children! Was the epidemic of 1510 influenza? The famous physicians Willis and Sydenham were certain that it was.

Dr. Short continued his studies on subsequent epidemics of influenza. He wrote of one that came at the beginning of the eighteenth century. Though originating in Dublin, it was called

the "Dunkirk rant" or "Dunkirk ague." It was a most remarkable epidemic, wrote Dr. Short, for, despite a careful search, he was unable to find any signs and omens anticipating it! Since there were none, he concluded that this epidemic must have been caused by climatic conditions. "This pestilence," he wrote, "had been preceded by a remarkably severe winter during which the Thames had frozen over solidly from bank to bank, and in every house bread and meal were all ice and urine froze under the bed, though there was a good fire in the room."

After concluding his study of influenza, Short wrote at length. He might have named his book *Influenza and Other Pestilences etc.*, or *Fundamentals of Influenza and Other Ailments; Their Causes and Prevention*, or *How to Remain Healthy in the Midst of Disease*. But he did not. Anyone who cares to read his work, may ask for Dr. Thomas Short's *A General Chronological History of the Air, Weather, Seasons, Meteors, etc.*, published in London in 1749.

The years passed but every few years influenza returned and the contemporary physicians wrote about it. There was Dr. Glass, who achieved a sort of immortality when he reported of the epidemic of 1580, "Whilst it was the general opinion of philosophers, that all things upon earth are governed by the heavens, physicians imputed the epidemic catarrhus semi-pestilential fever to the influence of the stars; whence the Italians gave it the name of *influenza*."

But in France, the disease continued to be called *la grippe* and this name remained unchanged and in common use up through recent times both in Europe and America.

As the influenza outbreaks continued, so did their signs and omens, all duly recorded by the physicians. They told of meteors, earthquakes and comets, of "wormy years" and "brown-tailed moths that laid waste the fruit trees," and how "in North Wales, almost all the horses were seized with coughs" while "in Dublin, dogs had sore eyes, large numbers of cats were seized with houst and many of them died."

Dr. Mease wrote voluminously about influenza, how it could arise in very many ways. He showed how climate affected it, how arid spells followed by rainy periods could stimulate the dormant seeds of disease and begin an epidemic. He explained how comets and meteors set the time for the beginning of each epidemic, how earthquakes and volcanic eruptions determined its duration, while bloody rains increased the severity of the illness. It was a scholarly study rich in knowledge and philosophy on the highest level, and of course the ultimate in the science of

the times. During the course of his researches, Dr. Mease fell ill with influenza and was bedridden for several days. He received the best of medical attention from his fellow practitioners and several times was on the verge of death. But he recovered, and continued his studies on influenza. He studied his own case and said, "I myself received the infection from a small trunk of wearing apparel which came from Dublin."

Dr. Hamilton had other theories; he connected influenza with lightning. He reported how, as a result of a violent thunderstorm with fireballs, three companies of soldiers were attacked by influenza all at once, and not a man among them was fit for duty for several days. It was the lightning that brought on the influenza; that was the immediate cause, said Dr. Hamilton. But it was the continuous imbibing of tea that weakened the body and made it susceptible to disease, for "infusions of tea—a debilitating liquor, injurious to the nervous system—is in such common use, that even paupers feed on it."

Then Dr. Hunter announced his cure for influenza—tobacco juice! "Drink a mugful of a strong infusion of tobacco in hot water three times a day or more," he said; "it will never fail to ease the illness and prevent new attacks." His remedy was not accepted by the medical profession, for somehow only Dr. Hunter seemed able to cure influenza with tobacco juice. The other physicians complained that tobacco juice as prescribed by Dr. Hunter was more deadly to their patients than the disease.

Meanwhile influenza had crossed the ocean to America, and there another physician, Dr. Warren, wrote in 1789, "The influenza, well known in Europe, invaded the whole of the United States in the course of last autumn. Our beloved President Washington is but now on the recovery from a very severe and dangerous attack of it."

The nineteenth century arrived. Inspired perhaps by Dr. Short, Noah Webster wrote his *Brief History of Epidemics and Pestilential Disease with the Principal Phenomena of the Physical World Which Precede and Accompany Them* . . . He taught that all epidemics of disease are caused by the same forces that produce earthquakes and volcanic eruptions.

In the nineteenth century the germs of influenza continued to be active, their signs and omens increasingly intricate and impressive. Many of the epidemics were now introduced by "red snow and red rain from a dark red cloud." It was noted significantly that before each epidemic "chicken blood was darker than usual and a great mortality was observed amongst fish. Ants swarmed in London and Brighton, the turnips suffered

from the ravages of wire-worm and large quantities of dead flies accumulated in hollow lanes."

The twentieth century moved closer, and with its approach influenza returned. The epidemic of 1889 came at a time of scientific exuberance and exultation. It arrived while it was being proved that disease and death among men were carried by invisible bits of hostile life. The science of bacteriology was being founded. Despite Pasteur and Koch, Roux, Yersin, Behring, Metchnikoff and Löffler, the germs of influenza erupted into the greatest epidemic of the old century!

If there were preliminary signs and omens, they have not been recorded. Suddenly people in many parts of the world complained of illness and abruptly died. All the nations of Europe were infected. Eskimos in Greenland died as readily as did Turks in Constantinople and Russians in Siberia, people in Asia and in North and South America. Thousands died each day. The total dead are not known—official records were not kept everywhere—but it almost certainly added up to millions.

Influenza struck everywhere for a few weeks, and then suddenly ended. It seemed to leave behind a world-wide gasp of consternation!

The theories and explanations that followed were interminable.

Physicians, scientists, historians, mathematicians and scholars, as well as men who had no qualification other than curiosity or conceit, studied, dissected, analysed, calculated, deplored and predicted. They admired their own work and occasionally they glanced at the work of others.

Some claimed that the epidemic had begun at Constantinople where influenza had been misdiagnosed as "dengue fever" and that it arose spontaneously in both Greenland and Siberian Russia.

Others insisted that the influenza began in Bokhara moved across to Russia, then over the eastern frontiers to Europe and from there to the rest of the world.

Still others proved to their own satisfaction that China was the origin of the epidemic; it was "Chinese Distemper" they said, and from China it moved at an incredible speed to Constantinople, then north to Europe, east to Russia and west to America.

A few decided that influenza travelled westward only, while others argued that it moved east and west simultaneously.

There were as many alleged trails of influenza moving over

the world in 1889 on the maps and charts of scholars as there were maps and charts and scholars.

"Influenza is caused by excess ozone in the atmosphere," said certain Italian physicians.

"Not so," said others of various nationalities; "it is created by morbid conditions of the atmosphere."

"Ridiculous! Influenza is not a disease," claimed certain other physicians. "It is a form of hay fever, caused by pollen grains of an unknown species of plant which flowers every ten years."

"Nonsense!" retorted still others. "Everyone knows that volcanic dust was thrown high into the air when Krakatoa erupted in 1883. Eventually the dust settled everywhere in the world, entering the lungs of men to cause the sickness and death known as influenza."

There were many who supported the Chinese Yellow Dust Theory. They pointed out that the Yellow River had overflowed that year and then receded, leaving countless tons of bright yellow mud distributed on both banks of the river along its entire length. The hot sun of China had dried the mud into dust, prevailing winds had whirled the dust around the world and influenza followed. The supporters of this theory remained serene when irritated scientist critics suggested that the Yellow River had in fact not overflowed its banks that year! They were unshaken when they were told that the prevailing winds of China were unsuitable for world-wide distribution of dust! They remained faithful to the Chinese Yellow Dust Theory even when it was proved that the bottom of the Yellow River was sandy and could not have dried into dust even if it had overflowed!

Another group of scholars who delighted in mathematical formulæ claimed to understand the cryptic symbols on nature's influenza timetable. Some of them predicted that influenza would return in ten years, others said fifteen, or twenty or thirty-five or fifty-five years. There was so very many predictions that, no matter when influenza would return, some scholar was certain to be right.

Was anything learned about influenza in 1889? It seemed so at the time, for Dr. Pfeiffer found the germs of influenza. But, as was discovered three decades later, they were the wrong germs; Pfeiffer's germs of influenza did not cause influenza. So, actually, nothing was learned about influenza from the epidemic of 1889.

The influenza epidemic of 1889 ended and the germs withdrew into a mysterious hibernation. Twenty-nine years later,

they emerged from their secret hiding-places and as in times past with portentous signs and omens.

There was a murrain among the horses and hogs of the American midwestern plains; the farm animals wheezed and coughed and died. There were always caterpillars, moths and worms among fruit trees, and undoubtedly storms and volcanic eruptions and earthquake tremors shook some lands somewhere. An inquiry among astronomers would certainly bring news of a comet, however small, in some distant quadrant of the heavens.

There was the turmoil of the war in Europe that was just ending, leaving the land riddled with destruction and the people brutalised by slaughter and debasement. There were bad times, and famine, for crops had failed and seeds cannot be sown on earth upturned in the fury of war.

There were red clouds over all Europe, commonplace clouds made ominous by the reflected fire of guns and cannon. There was red dust blowing over the battlefields, and when the rain fell it fell in blood-red drops.

Great metal objects screamed and whistled and dropped from heaven to earth with a roar, to dash themselves to pieces. Sometimes they made no sound, but puffed up into a ghastly mist that choked men and ate the flesh from their bones.

There were no reports of the birth of human-headed goats or many-headed monsters that so frequently accompanied the great pestilences of the past. But there were reports of the birth of other sorts of monsters. There were strange monsters that rumbled over the ground, crunching metallically as they crushed men beneath their iron feet. There were other monsters that flew in the skies and scattered death from their enormous wings. There were monstrous men who had no skin, their insides held together by metal and cloth and leather. There were lobster men whose hands were claws, dwarf men who walked on stubs, turtle men who existed in baskets. And there were many small grotesque creatures resembling children, whose empty stomachs bulging outward contrasted ludicrously with their shrivelled faces and searching eyes.

These were the omens that had begun four years before the greatest of all epidemics.

It was first noticed in September, 1918, reached its climax in November, ebbed in January and disappeared in March, 1919. It seemed to blaze everywhere in the world at once. In the United States, twenty million were infected and one half million died. In Asia so very many died the total is incredible; some say five million in India alone, other say twelve million.

In the interior of Africa, hunters and explorers were amazed to find that whole groups of villages had disappeared, the primitive huts wiped free of human life, the crude streets and fields nearly obliterated by the ravenous green life of the jungle. From Laplanders, Icelanders and Eskimos, from Terra del Fuegians and New Zealanders, from each of the myriad islands that adorn the waters of the South Pacific came news of sickness and death. The toll over all the world added up to more than two hundred million sick, at least twenty-one million dead of influenza.

In America it was the "Spanish Influenza," in France they called it "Purulent Bronchitis," in Italy it was "Sand-Fly Fever," and in Japan it was known as "Wrestler's Fever." No matter what it was called, it was the same disease everywhere, and life or death was predetermined at the moment the germs of influenza began their infection and there was nothing man could do to change their course. The illness began with headache, chills and fever, with sharp pains in the back and legs. Then the victim collapsed. His mouth and throat turned "flaming red," he coughed agonisingly, his breath came in painful sobs and he was drenched in sweat. Suddenly his heart beat would cease or he might as suddenly sit up in his sickbed, weak and trembling but restored to life. This was the influenza of 1918; there was no other disease like it.

Then twentieth century is a century of progress in science, in the knowledge of diseases and the germs that cause them. But what could be done to cure or prevent influenza?

Said Dr. Soper, "We are as helpless against influenza as were our ancestors against smallpox before vaccination."

Wrote Dr. Maxcy, "The pandemic of influenza in 1918 was an appalling demonstration of man's helplessness and ignorance."

Explained Dr. Le Count, "It took physicians by surprise; we thought it was a new disease. We did not know what we had."

Stated Drs. Smith and Conant, "... influenza is not susceptible to any known therapeutic agents."

Reported Dr. Jordan, "The outbreaks cannot be traced from point to point; no other disease is as able to spread over so wide an area of the earth's surface in so short a time."

Orders were given to send all influenza patients to the nearest hospital. Soon the hospitals overflowed, with beds in waiting-rooms, along corridors, in locker rooms. Wherever there was space, there were beds and influenza patients. And then the family physicians, the general practitioners, the hospital residents and the health department men noticed something strange

—hospital patients died more frequently than those who were nursed at home!

Influenza vaccines were prepared and thousands of persons were vaccinated, and those vaccinated were more susceptible to influenza than the unvaccinated!

In many cities, all schools and theatres were closed, all public meeting places padlocked. In San Francisco and Sacramento they did this and more—they issued nose-and-mouth masks to all of their citizens. Everyone wore masks, avoided crowds and tried to avoid infection, but, with or without masks and locked doors, sickness and death from influenza continued unchanged.

When influenza arrived in Alaska, in the city of Fairbanks, it was decreed that everyone (for the sum of one dollar) must wear a blue ribbon armband marked "O.K. Fairbanks Health Department." Anyone found on the streets without an armband was liable to be arrested and quarantined (in the local jail) for five days or more. All roads into town were guarded by armed men, all homes with influenza were placed under police guard. But the epidemic in Fairbanks was no different than in other Alaskan towns that had no quarantines and armbands.

In the city of Hamburg, Germany, there were no quarantines or armbands or masks, but the health department officials had other problems. In Hamburg there was an acute shortage of coffins and hearses. They finally solved the problem—jute sacks and furniture vans disposed of the influenza dead.

As the epidemic continued, the medical journals were so crowded with articles about influenza that it seemed as though only influenza and no other disease existed. A physician wrote, "Influenza! Is it a hazard to be healthy?" Another physician claimed, "Influenza is a misnomer! The disease influenza does not exist, only nasal sinusitis!" A third observed that the hiccoughs were becoming more prevalent, and he warned that a deadly epidemic of hiccoughs would soon follow. And there were certain physicians who theorised on the cause of influenza—they said it resulted from atmospheric pressure, or dust storms, or cosmic rays, or anticyclonic weather, or ozone, or dirty dish water, or coal dust or from the distemper of cats and dogs and their fleas or from inhaling the breath of coughing horses.

Sickness and death continued. Although masks had failed to stop influenza in San Francisco and Sacramento it was recommended that masks be manufactured in enormous numbers to be worn by everyone at all times. Plans were drawn up describing methods of increasing the hospital bed capacity a thousand-

fold, even though everyone knew that influenza was more deadly in hospitals. Preparations were made for disinfecting the water supply, the food, clothing and furniture, for fumigating of homes and public buildings, even streets and sewers and wharfs and ships, although no one was prepared to show just how these measures would reduce or prevent influenza.

And in the midst of all the planning and preparation, influenza quietly disappeared.

When influenza had gone and calm reason had replaced hysteria, scientists studied the epidemic of 1918-1919 with the accumulated wisdom of the twentieth century.

Influenza began, said some twentieth century scientists, at Camp Funston in Kansas during September, 1917. By March, 1918, it had spread to the nearby town of Haskell, and it sailed across the Atlantic to France with the Camp Funston contingent of the American Expeditionary Forces. From there it spread to all parts of the world.

The fire of influenza was ignited in Chungking, China, on precisely the twenty-seventh of July, 1918. On that day, one half of the Chinese in Chungking suddenly sickened with influenza, the disease beginning among them by a sort of spontaneous combustion. It spread to a Japanese freighter and was carried over the seas to burn throughout all Asia. It came to France on a slow fuse among Chinese labour troops, smouldered among them as a mild febrile disease and then burst into flame in the autumn of 1918 over all of Europe. So contended other scientists.

Others claimed that it broke into flame in India, or in France, or in Spain or in Britain.

And as a final verdict in this the twentieth century of progress in medical science, it may be concluded that influenza in 1918 arose among some soldiers or civilians or both, of some nationality, in either one or more nations of the world, at the same or different times.

The germs of influenza were discovered in 1933. They are small bean-shaped viruses, named influenza virus type A, type B and perhaps other types. Several times in the past, the germs of influenza had been discovered, and the discovery found later to be in error. First the germs of Pfeiffer, followed by the germs of Olitsky and Gates, then the germs of Mathers and Falk and recently the swine influenza germs of Shope were all accepted and later rejected as the cause of influenza.

In a certain laboratory, a group of scientists did research on

influenza. They injected the bean-shaped viruses into human volunteers, and the volunteers developed influenza. The scientists wrote up their experiment as a scientific paper and it was published in a medical journal. They were very careful scientists, so they repeated the experiment to be certain that these germs were indeed the germs of influenza. They injected other volunteers, but these volunteers did not get sick. They injected more volunteers; then they injected each other and everyone in their laboratory, and all remained healthily free of influenza. It was bitter and embarrassing, and they wrote to the editor of the medical journal asking that their research paper be withdrawn.

In another experiment, germs taken directly from a patient who had died of influenza were injected into volunteers. Not a single "take" resulted, none of the volunteers developing influenza.

In a third experiment, other human subjects were injected with influenza germs. Some of them were sick, some were not sick at all, and some felt mildly indisposed. Was this influenza? The scientists were not sure.

Many scientists believe that the germs of influenza cause a mild disease. Influenza, they say, only destroys the normal resistance of the human body. Influenza germs do little harm, but as they invade they leave the gates ajar for pneumococcus, staphylococcus, streptococcus and other deadly germs to pour in unhindered and overwhelm the unresisting body. These scientists suggest that the germs of influenza be named *Tarpeia* after the legendary Roman maiden who treacherously opened the gates of Rome to the enemy.

As our modern scientists study influenza, the germs become more and more perplexing. The solution to their many enigmas retreats as we approach them, and ignorance seems to grow as learning increases. Instead of discoveries, new enigmas are uncovered for which we find no answers. Over the past centuries, the epidemics of influenza have become increasingly deadly; the epidemic of 1918 was far more virulent than the epidemic of 1889. When the next great outbreak of influenza strikes the world at some unknown time in the future, will it be the greatest pestilence of all time? And what will be the signs and omens?

CHAPTER XV

THE INTANGIBLE GERMS OF
DISFIGURATION AND DEATH

SOME SAY it all began in the year 64 B.C. when Rome invaded Syria. There were lootings and pillagings everywhere as the victorious Roman legions overran the countryside, destroying everything that they were unable to consume or carry away. They came into a temple of Apollo seeking gold and jewels, and there they saw a sacred place and in it a sacred box. It was a very old box, locked and sealed with a potent spell fashioned by ancient Chaldean necromancers. But the Romans forced open the box, and its invisible contents poured out. Seeds of pestilence leaped out at the Romans and suddenly their faces grew livid with loathsome sores. Some fell lifeless at once, some were able to escape though dying as they fled. Others who managed to reach their camp could not elude the ancient spell for they died terror-stricken in their tents. Even when they were able to flee far back through the gates of Rome and into the heart of the Eternal City, the seeds of pestilence followed them. For fifteen years pestilence raged in Rome as the Chaldean curse unfolded into the first great epidemic of smallpox.

Some say that smallpox originated by other means in China, India, Africa or perhaps the region of the Caspian Sea.

Wherever their origin, the germs of smallpox arrived in Europe and expanded slowly into towns and villages that had never known the disease. The germs expanded slowly because they were so deadly. Travellers who spread the germs died quickly or were bedridden until they were well and no longer contagious. During the era of the Crusades, smallpox expanded rapidly. The fever of smallpox seemed not to retard the swiftly retreating Crusaders and, in lieu of trophies of victory, they brought home smallpox germs.

Early in the seventeenth century, the first great smallpox epidemic of Europe erupted among a terrified populace. Epidemic followed epidemic closely upon the heels of one another and smallpox became a major pestilence among the many that plagued humanity. Every year was a year of smallpox in Europe;

livid sores and death became commonplace terrors, thousands died, and thousands of others were left with hideous scars on face and body or groping their way through winding streets with eyes made blind by smallpox. Smallpox reigned unchallenged in the centres of western civilisation.

In those parts of the world where western civilisation was unknown, smallpox was not a dreaded pestilence. Chinese physicians had long been aware that dried matter from smallpox spots when rubbed into the nostrils created immunity against the disease. Early in Indian history, Brahmins had learned to rub smallpox matter into the scratched skin of the arm or forehead. In Persia, physicians had known for many centuries how to prepare dried virulent material in the form of pills, to be swallowed by their patients. And wherever this ancient practice of inoculation was used systematically, smallpox declined.

In England, in 1714, a year notorious for death and blindness by smallpox, a Dr. Timoni published a description of the method of inoculation for the prevention of infection. But he was ignored.

The following year, Dr. Pylarini published the method of inoculation in Venice and Dr. Kennedy did the same in London. Both men were ignored.

Two years later, Lady Mary Wortley Montagu saw inoculation being practised in Turkey. She had her own son inoculated and, when she returned to England, brought with her the details of this ancient practice. Her influential friends spread her message everywhere. She could not be ignored, But she aroused a rage of opposition and animosity over all of England. The physicians were incensed because they were certain that inoculation was a hoax; it would not prevent smallpox, they said. They warned about the dangers of laymen meddling in matters that belonged properly to physicians and predicted dire results if inoculation were allowed to come into general use. The clergy too were aroused. They were convinced that inoculation was not a hoax and that it would prevent smallpox. But smallpox, they said, was visited upon man for his sins, and it would be impious to take man's destiny out of the hands of providence and place it in the hands of anyone possessing an inoculating lancet and smallpox matter. And the common people were also agitated against Lady Montagu, for witch-burnings and hangings had been few and like entertainment scarce that year; they hooted at this unnatural mother who submitted her son to the danger of inoculation. As for Lady Montagu herself, although she retained her faith in inoculation, the uproar that it caused was so great that "she seldom passed a day without repenting of her patriotic

undertaking; and she vowed that she would never have attempted it if she had foreseen the vexation, the persecution, and even the obloquy it brought upon her."

Inoculation was fiercely resisted, first in Europe and later in America. But smallpox has a sobering effect upon opinions, however lofty or ingrained. Whenever smallpox threatened, opinions and prejudices were quietly abandoned and the practice of inoculation slowly achieved an uneasy and unofficial acceptance.

But some inoculations caused genuine smallpox and about one out of every fifty inoculated persons died from this cause. In the cases that were only mildly ill, the germs remained deadly and an inoculated person might transmit smallpox to the uninoculated and ignite a widespread smallpox epidemic. Inoculation was effective but dangerous. It was not the complete solution to the problem of smallpox.

He lived in the vale of Gloucester and his name was Edward Jenner. He had straw-coloured hair and china-blue eyes. He took pleasure in watching birds in flight and in listening to their song. He collected rocks and fossils. He recited poetry and set the stanzas to music. He wrote *Observations on the Night-Blooming Primrose*, and his *Address to a Robin* began :

" Come, sweetest of the feather'd throng!
And soothe me with thy plaintive song."

He also performed on the flute and the violin, frequently selecting music which he himself had composed, and he customarily dressed in "a blue coat and yellow buttons, buckskins, well-polished jockey boots, with handsome silver spurs, and he carried a smart whip with a silver handle."

He dreamed of a life filled with poetry and music, but the Jenner family tree was irreconcilably bent into the traditions of medicine and medical practice. So, in the late 1760s, off to study medicine went young Jenner, as his father and his forebears had done before him. He went to Sudbury to learn surgery and pharmacy. He went unhappily, leaving behind his manuscripts and his music, his bird nests and his collection of fossils. Mostly he mourned for his poetry; he could not know that a John Keats would also attend medical school. Years of study followed, memorising bones and nerves and veins and arteries, studying muscles and ligaments and tendons and their arrangement. He learned the names of many drugs and the components used in their formulation, how to roll pills and care for leeches, to apply

poultices and cataplasms, prepare elixirs and emollients, and tell the difference between cholagogues and cholcretics.

While studying with the famous John Hunter, living in his home and eating at the table with the Hunter family, Jenner became interested in the art of medicine. He learned about smallpox and it fascinated him. And when a young girl came to him for medical attention, he warned her against its dangers. To his amazement she corrected him. "No, sire," she said, "I cannot have smallpox because I have had cowpox."

At the conclusion of his apprenticeship, he postponed his return to his music and his verse, preferring to investigate smallpox and cowpox. He was astonished to find that the problem of the prevention of smallpox had been solved in Gloucestershire, and all the folk of the countryside knew of it, all except the physicians. "Become taken with cowpox and you will never take smallpox," said the dairymen, the farmers, the hired hands and the milkmaids. But the medical men laughed at rural superstitions and, when Jenner spoke to them of cowpox, they laughed at his credulity.

He ceased to discuss smallpox with his fellow practitioners and he attended faithfully to his own medical practice. He took to himself a wife and fathered a family, and found time to study and work on smallpox and cowpox.

He kept neatly detailed records of his work, noting how Sarah Portlock, Mary Barge and Elizabeth Wynne, and Simon Nichols, Joseph Merret and William Rodway, had "taken" cowpox, and how they showed immunity when he inoculated them with smallpox. He repeated his observations on others, and years passed as he accumulated page upon page of records of cowpox and smallpox. Eventually he was satisfied. He was convinced that the people who had taken cowpox were without exception immune to smallpox.

Jenner's crucial experiment was done in 1796. He took cowpox matter from the hands of Sarah Nelmes, dairymaid, and with it he vaccinated the arm of eight-year-old James Phipps. Two months later, Jenner inoculated Phipps with smallpox on both arms, and several months later he repeated the inoculation. There was neither fever nor pocks, only a trivial sore at the point of inoculation typical of immunity.

Jenner wrote up the results of his experiments and sent them to the Royal Society for publication in their *Transactions*. He was not surprised when the manuscript was contemptuously rejected and returned to him. But he was stubborn, though he was a gentle man, and he published his work at his own expense in 1798: *An Inquiry into the Cause and Effects of the Variolæ*

Vaccinæ, a Disease Discovered in Some of the Western Counties of England, Particularly Gloucestershire, and Known by the Name of Cowpox.

Smallpox was solved, thought Jenner; his scientific work was at an end and now he would find time for his poetry and his music. But that was not to be, for his vaccinations had aroused a tide of bitter opposition far more violent than that which had greeted Lady Montagu and inoculation. And poor Jenner, bewildered by torrents of abuse, wrote in anguish, "One says cowpox is very filthy and nasty! Another, O my God, says we shall introduce the diseases of animals among us, and we have too many already of our own! A third sapient set say that it is a strange kind of business, and they know not what to think of it!" And, against his will, he found himself, embroiled in controversy writing and debating endlessly the merits of vaccination.

Anonymous pamphlets appeared everywhere, addressed to the common people and illustrated with crude drawings of children before and after vaccination, showing them in various stages of change into cows and bulls.

Many physicians questioned Jenner and his work, but not Dr. Ingenhousz—he insolently *demand*ed that Jenner withdraw his entire theory and practice of vaccination. "Cowpox and vaccination are hoaxes," said Dr. Ingenhousz, self-styled "Physician to the Emperor and King"; "they confer no immunity whatsoever against smallpox," and he listed a number of patients who, he said, had been vaccinated and who had nevertheless contracted smallpox afterward. Through his lectures and writings, Ingenhousz acquired a large and noisy following. They tormented Jenner and circulated petty slanders about his family, saying he did not dare to vaccinate himself or his children. They refused to acknowledge his replies and they ignored his arguments, attacking him meanwhile with a malicious persistence.

Jenner had supporters who admired and believed in him, although many of them could not understand neither his work nor the principles of his science. They were ignorant of the difference between the contagion of smallpox and of cowpox—an ignorance they were reluctant to admit—and indiscriminately mixed smallpox and cowpox on their vaccinating lancets; when their patients died of smallpox, they stood on their medical dignity and left it to Jenner to "explain" why the patient had died.

Frequently bitter antagonists of Jenner would become converted, suddenly reversing their ground and accepting vaccination. Then they would blithely ignore Jenner and his years of research, saying he had discovered nothing; the countryfolk of

Gloucestershire had discovered vaccination. Or, they said, it was so simple, so obvious, that anyone could have thought of it; it was no credit to Jenner.

Gradually, over the years, Jenner's detractors dwindled and became silent, Dr. Ingenhousz slowly faded into a well-deserved obscurity. In their place came honours—scrolls of appreciation, plaques of acknowledgment, wampum from American Indians and medals from kings and emperors, diplomas and testimonials from universities and scientific and medical societies, and simple letters of thanks from plain people. Thomas Jefferson wrote in 1806 of Jenner, "You have erased from the calendar of human afflictions one of its greatest. Yours is the comfortable reflection that mankind can never forget that you have lived; future nations will know by history only that the loathsome smallpox has existed, and by you has been extirpated."

Imperceptibly, Jenner found himself grown old and lonely, for his favourite son had died, and he was even more alone after the death of his wife. He tried to resume the gentle pastimes of his youth, but it was too late. With old age and disuse, fingers turn stiff and they can neither find the stops on the flute nor move nimbly on the violin strings. So he wandered over the countryside and studied natural history. He was interested in freemartins; he kept a pet eagle; he wrote of earth-worms and described how they continually dug up the earth, keeping it porous and soft, suitable for the growing of plants..

He had never complained of his trials nor had he ever exhibited with pride his honours, and in the last years of his life he seemed to forget entirely about smallpox and cowpox. He talked of poetry and music, and for several evenings before his death he thought only of his wife, speaking of her as though she were alive.

Because of Jenner, smallpox declined. It came to be regarded as a medieval pestilence, arousing images of narrow streets and narrow minds, of peaked roofs and crowned heads, of gaudy costumes and colourful trappings moving with pomp among the abject and degraded humanity of the Dark Ages. But smallpox is also a modern disease. Great epidemics have become rare, but thousands of victims continue to suffer from the scourge of the Dark Ages, their horribly livid faces staring in pain and fright from the immaculate white bedding and gleaming metal of modern hospitals.

The intangible germs known as viruses cause smallpox, and in the first quarter of the twentieth century they erupted steadily in the United States. But the germs of smallpox, which had des-

troyed millions of people in earlier times, seemed to have become impotent in modern America. Only in America, however, were the germs feeble. In India they were as powerful as they had always been, one million persons infected and half of them dead during the 1920s; in the same period, although half a million Americans were attacked by the germs of smallpox, only a handful of them died. Smallpox came mildly in 1921 to Denver and Kansas City, and to Detroit in 1923, thousands being infected by the germs and nearly all of them living on afterward. In Minnesota, smallpox had been a frequent visitor from 1913 to 1923. Each year the germs returned and infected a few thousand Minnesotans with a benign illness. Smallpox became a familiar nuisance in Minnesota. There was reason to believe that the temperate climate of the United States, its invigorating atmosphere, the abundance of good food and the superlative hospitals all had combined to counteract the virulence of the germs of smallpox.

When smallpox came again to Minnesota in 1924, the victims were removed to hospitals for a routine recovery. Suddenly there were tears and dismay, for the germs had become deadly and many of the patients did not recover! In the hospitals, physicians and nurses were shocked when their smallpox cases unexpectedly died; in that year, fifteen hundred Minnesotans were infected and four hundred died!

There were numerous investigations and intensive studies, and finally there were explanations. It was learned that there are two kinds of germs of smallpox and they cause two kinds of disease: smallpox *major* and smallpox *minor*. The first is deadly, the second mild; and climate, atmosphere, diet, sanitation, physicians and hospitals are irrelevant factors. The germs of smallpox *major* thrive in India and at least half of those infected are certain to die. In America, for no apparent reason, the germs of smallpox *minor* predominate, but the deadlier germs are not entirely absent and they may erupt at any time, as they did in Minnesota in 1924.

The threat of pestilence always hangs darkly over the great city of New York. The city is so impossibly large, its manifold elements so diverse, and so very many people pass daily in and out of its human denseness, to brush against one another and exchange the air they breathe. It is an enormous thoroughfare to which germs of pestilence from all the lands of the world eventually penetrate, where some germs pass through, and others remain to propagate their species and breed each its own kind of disease.

In the year 1947, New York was menaced with pestilence. The shadow of a black horseman dimmed the brilliance of the sky over Times Square and brought an ancient terror to the city dwellers. Over the five boroughs and across the Hudson and the Jersey meadows, to the north and east, hovered the image of swift death, of horrible sores and blindness and ugly pitted scars. From below the Rio Grande had come not alone the shadow but the substance of pestilence—the germs of smallpox major. They threatened the ten million humans confined within Greater New York City.

The smallpox epidemic began when a business man bound for New York boarded a bus in Mexico . . .

All this happened a decade ago. Since then, the story of smallpox in New York has been narrated over and over again until now each narrator tells a slightly different tale. The facts have turned partly into legend and partly into fable—they have become history.

So one historian says it was not a New York business man but a Mexican exporter who started the epidemic, though a second historian denies it. The business man was not really *en route* to New York insists a third, while a fourth historian shakes his head, he only stopped off on his way to Maine. No, he took the bus not in Mexico but in Texas! Yes, he walked to the hospital. No, he collapsed and had to be carried there! Yes, the diagnosis was correct. No, his illness was not diagnosed until three weeks after his death! Yes, his body was buried in a sealed coffin and a deep grave. No, he was cremated at the request of his widow! Yes, the health department was notified at once. No, the health department couldn't possibly have been notified because the diagnosis was incorrect! And so on.

The following version of how the germs of smallpox came to threaten New York City is taken from contemporary medical journals.

The smallpox epidemic began when a business man bound for New York boarded a bus in Mexico. He felt, indisposed when his journey began, he sickened as it continued, and when the bus reached New York he collapsed. He was taken to Bellevue Hospital and there his ailment was diagnosed as a dangerous contagious disease.

Then around his bed of pestilence there was the rustle of stiff white uniforms, the sound of voices subdued in urgency, the faint hiss of footsteps and rubber-wheeled carts. There was restless quiet everywhere and the soft vibrations of a muffled

bell ringing eternally. Only the sick man was unconcerned; his sickness had preoccupied him and he had no interest in the events of the surrounding world. Bellevue Hospital, having no isolation ward, is not suitable for the treatment of a dangerous contagious disease, and the sick man soon travelled by ambulance to the Willard Parker Hospital for Contagious Diseases. There his illness was studied, and on the chart the attending physician wrote *smallpox*!

There was nothing more that medical science could do for him, except to observe and record on the chart the development of the signs and symptoms of smallpox major. Despite the scar of vaccination clearly marked on his arm—it was an old scar, his vaccination no longer protected him—the red spots appeared on his face and hands and feet, and then everywhere over his body. The pustules of malignant smallpox erupted densely and crowded one upon the other, until scarcely a trace of unmarked skin could be seen. Then he died. Hurriedly his cankered body was sealed into a coffin and hastily buried deep in the cleansing earth of the graveyard. His case history, the charts and the fever curves, the cards and the certificates alike, were also buried deep in the hospital files, in the hope that they might become yellowed and dusty and forgotten.

But the germs of smallpox could not be filed away and they do not allow themselves to be easily forgotten. Shortly afterward, two patients at the Willard Parker Hospital suddenly turned feverish and red spots erupted on the skin of their face and hands and feet. The hospital staff could do nothing for them—they could only watch the ancient and ever recurring struggle between germs and the human body, and stand by as it ran its course—but they could protect the uninfected. Previously vaccinated or not, indignant, protesting, fearful or willing, all the patients in the ward where the germs from Mexico had recently sojourned were vaccinated, and the vaccinations were carefully inspected to be sure that they had “taken,” and those that had not were done again.

Then physicians and nurses relaxed, but their respite was brief, for smallpox major flared again. The germs attacked the wife of one of the former patients in the “smallpox” ward. She had visited her husband, and her short stay was sufficient for the germs. The onset of her illness was abrupt and soon over, for she had little resistance and was spared the ordeal of a lifetime of ugliness. Instead of ending in pits and scars, her smallpox terminated in quick death.

Now there was no longer any complacency among the medical staff of the Willard Parker Hospital. Everyone in the hospital

was hurriedly vaccinated—patients, visitors, nurses, orderlies, bacteriologists, chemists, superintendents, physicians, pharmacists, technicians, dietitians, cooks, clerks, ambulance drivers, elevator operators, window washers boiler engineers handymen, internes, receptionists, launderers and librarians. Hospital officials traced the movements of all who had visited while smallpox had been in residence—food and uniform and bedclothes suppliers salesmen, deliverymen, policemen, firemen—and vaccinated them all. They traced the associates and families of the patients and vaccinated them. Then the medical staff rested and waited uneasily for the terror to subside. They had done everything that could be done to exorcise the malignant devils of smallpox.

As they rested and waited apprehensively, smallpox erupted again. At Bellevue Hospital where the germs had visited briefly, three patients broke out into the dreaded red sores.

Back at Willard Parker Hospital, a small boy, after an incredibly short exposure to the germs of smallpox, had been sent home. He distributed the germs to three members of his family. Though he himself showed no signs of disease, his family suffered with a violent smallpox infection.

Meanwhile there were the other passengers on the smallpox bus from Mexico; their families, their business and social and casual associates had yet to be traced. Among the governing authorities at the two hospitals, there arose a dismaying thought of a ride in the New York subway, however short, by a single carrier of the germs, how it would broadcast the germs far and wide over every part of the city, and how, while the first smallpox contacts were being traced, new contacts were constantly being made and spread. And the authorities at Bellevue and Willard Parker, recognising the hopelessness of attempting to track down the elusive germs of smallpox, took their problem to the City Health Department. There a daring plan was suggested, quickly approved and immediately acted on. It was simple and it was direct—*everyone* in the city of New York was to be vaccinated!

To every health department in the United States, to every large medical centre, to every manufacturer of smallpox vaccine, everywhere vaccine was to be found, urgent requests went out to send at once all available vaccine to the New York City Department of Health. The requests were honoured and smallpox vaccine poured into New York City.

Each vaccine "shot" is a small hollow glass tube, the size and shape of a toothpick, sealed at both ends, and containing a drop of clear colourless fluid, a living germ culture, scraped from the skin of a cow that had been inoculated with cowpox and

preserved in glycerine. The glass tube is wiped with alcohol to sterilise it, and then it is broken in the middle, allowing a drop of fluid to ooze out onto the skin of the arm or leg. Using a sterilised needle or the broken edge of the glass vaccine tube, the vaccination is made by scratching the skin lightly through the drop of fluid.

And so it began—the vaccination of the entire population of New York City. Little urging was needed and no compulsion; the vision of hideous sores and death urged and compelled. The ancient terror of smallpox drove modern New Yorkers from their homes. They demanded to be vaccinated at once, complained and threatened, crowded together and stood for hours in interminable lines at the health stations awaiting their turn. In less than a month, nearly seven million people had been vaccinated; it was the greatest feat of preventive medicine in the history of mankind.

As the vaccinations progressed, a mild frenzy overran the city. Every skin eruption caused suspicions and fears, and many an owner of an ordinary mottled skin found himself avoided by passers by and ignored by his associates and friends, his presence arousing a strained atmosphere even within the bosom of his family. Phones rang endlessly in the city health offices with frenzied reports of small pox. The physicians sent to find smallpox found only chickenpox and napkin rash, allergies and adolescent pimples. They prescribed innocuous and soothing remedies, reassured the frightened, suggested that it would be best for those with skin blemishes to remain at home until the blemishes disappeared or until the smallpox epidemic had been forgotten.

The vaccinations eventually ended, the last frightened New Yorker received his inoculation of the germs of cowpox, but the Health Department phones continued to clamour. Now it had become the vaccination that was feared, and to its aftermath was attributed illness and death indiscriminately. When there is no smallpox in New York City, two hundred of its people die each day of various causes, and when smallpox and vaccination visited the city in 1947 two hundred of its people continued to die each day. Now, after vaccination, the kin and friends of those who died restrained their grief long enough to phone the Department of Health. They complained that vaccination had cut short the life span of their loved ones; they threatened violence and lawsuits and promised to vote for the opposition. Every fever, every cough aroused suspicion, and vaccination scars were eyed with apprehension.

At one time rumour said that vaccination would cause abor-

tions and sterility, that pregnancy would be rare and could terminate only in miscarriage or stillbirth. There were a few who believed the contrary, who maintained stoutly and tearfully that, if they were indeed pregnant, it could not have happened unless it had been the needle prick of vaccination that had caused it.

Eventually the panic in New York subsided, the citizens commented less frequently on their vaccinations, fewer scars were compared, and smallpox was ignored and soon forgotten.

In the Health Department, the results of the mass vaccination were tabulated and studied. Of the nearly seven million New Yorkers who had been vaccinated, two-thirds had shown a strong smallpox reaction, proving that they were definitely susceptible to smallpox and their bodies would have offered no resistance if exposed to the germs. Most New Yorkers were found to have been vaccinated previously, but after seven years the protection of vaccination becomes weak and uncertain and vaccination must be repeated.

Among the nations of Europe, it is believed that encephalitis always attacks a small proportion of those who have undergone vaccination; in New York there were a few cases of encephalitis but no more than normal, and they were proved to have had no connection with vaccination. There was one death caused by vaccination, but death came from an accidental infection with other germs and not those of smallpox or cowpox. Two infants died, not of vaccination, for they had not been vaccinated; they succumbed to a smallpox-like disease and it was believed that they had needlessly been exposed to germs from the vaccinations of their family group.

In the great metropolis of New York where pestilence always threatens, the smallpox epidemic of 1947 ended a few weeks after it began. Ten million people had been menaced with disease and most of them had been potentially susceptible to the germs.

In Europe during the eighteenth century, sixty million people had succumbed to smallpox. The Spanish brought smallpox to the New World and six million American Indians died. When an epidemic erupted in Iceland, within a week one third of the population had died. In old Boston, smallpox entered the port to take the lives of one half of the city's citizens. Smallpox spread to Australia and the germs nearly exterminated the aboriginal population. Smallpox descended on Germany during the Franco-German War and two hundred thousand Germans died miserably, many times more than the number that perished gloriously while fighting on the battlefield.

And in New York in 1947—If the germs had been allowed to spread unhindered as they had done in Europe and Iceland or Boston and Australia, then in the great city of New York more than three million would have died within a few weeks. Another three million would have survived but they would have been marked indelibly by scars of smallpox.

In New York in 1947—the men who work obscurely in the Health Department were gratified, and somewhere in another sphere the spirit of Edward Jenner may have looked up briefly from his flute and smiled broadly—a holocaust of death and disfiguration had threatened ten million people, but only five persons had died and twelve were disfigured by smallpox.

CHAPTER XVI

THE REVELATIONS OF DR. BENJAMIN RUSH

IT WAS a most mysterious fever. It seized upon people and they turned yellow, vomited black and died. It came more severely in some years than in others and it came always in late summer when the mosquito wigglers in the stagnant waters of marsh and harbour had hatched into adult mosquitoes that winged their way into every part of the city. But the mosquitoes were reckoned to be merely a coincidence and an additional harassment that added to the misery of illness and death. Yellow fever came first to the waterfront areas, near rivers and ponds and swamps, wherever there was water and mosquitoes might breed. But this was also a coincidence. The pestilence disappeared when the weather grew cold and winter approached and the mosquitoes disappeared—merely another coincidence.

Some scholars believed that yellow fever came originally from Africa, others declared that it was spawned in Central and South America. It mattered little where it had come from, for it soon spread everywhere over the world. As we know now, germs of yellow fever are carried by mosquitoes, and mosquitoes once were carried by sailing ships. Germs and mosquitoes, unknown to the men of those times, sailed over the seas and oceans, into rivers and lakes and harbours. Yellow fever entered sea-ports and valleys, wherever there was water and where the

climate would allow mosquitoes to breed and fly and bite, there the germs would disembark and spread a pall of yellow skins and black vomit and painful death.

In the past, no one knew where yellow fever came from or how it could be healed—only Dr. Rush knew positively that it was “morbid atmosphere” that caused the disease and that it could be healed by purging and bleeding.

Dr. Benjamin Rush became embroiled with yellow fever when the germs came to Philadelphia in 1793. In August the epidemic had begun, and slowly increased in violence. Up and down the streets of Philadelphia the fevers raged. They penetrated into the alleys along the wharfs, among the ramshackle homes and gaudy whorehouses that lined the waterfront, and up into the promenades between the stately mansions on the hill. Everywhere were the dead and dying of yellow fever, and everywhere yellow fever was, there was Dr. Rush. He had patients in every part of Philadelphia. He treated a young wife here and she died; he attended a young boy there and he died; he prescribed for an old man elsewhere, and a middle-aged man in another place, and both died. He continued to purge and bleed and raise blisters, and, although his visits benefited his patients not one whit, he remained confident of his healing powers as he watched them die. When the final convulsion had passed and the heartbeat had ceased, then Dr. Rush arose from the bedside, presented his bill to the grieving kin, bowed and put on his hat, running down the doorsteps to his carriage to drive swiftly to the doorstep of another patient.

The days were hot and everywhere people remarked on the smells, more intense and offensive than they had ever remembered; in truth, it was the worst smelling summer they had ever known. There was garbage in the alleys and dead fish and tar and rotted wood pilings along the wharfs. There was the dank reek of marshes and sewers and of stagnant water in the canals. The entrails of cattle and poultry and fish putrefied in the market places amid mouldy fruit and decaying vegetables. And overwhelming and permeating through all the others was the stench of rotted coffee beans. A tremendous mound of coffee rested on the wharf where it had been dumped the month before, an entire ship's cargo deposited to remain until its ultimate disposal should be decided.

The heat was distressing; Rush sweated freely, wiping his face and swatting at the mosquitoes that tormented him. He noted that the mosquitoes were more numerous than usual, but he ignored them, and he shrank from the nauseating odours that the summer heat had aroused and intensified everywhere in

Philadelphia. The rancid aroma of rotting coffee beans swirled ceaselessly about him as he hurried on his rounds. Most of his patients who had succumbed to yellow fever resided close by the wharf where the coffee rotted, and died in an aura of spoiled coffee beans. Suddenly Dr. Rush had a revelation. Yellow fever must be caused by the stench of rotting coffee! Those closest to the source inhaled an overwhelming dose and died despite his ministrations!

Dr. Rush was delighted. He forgot about sweat and heat and mosquitoes, and he ran to tell all Philadelphia of his great discovery. He ran to the mayor of the city, to the governor of the state, to the port physician and the health officer.

"The coffee," he said breathlessly, "it exudes the miasm of yellow fever! It is the fount of pestilence! This rotting heap must be removed or the yellow bilious fever that comes of inhaling morbid atmosphere will spread over all of Philadelphia! It must be removed at once!"

The men to whom Rush spoke were calm and deliberate. They listened courteously and as they ushered him from their office they agreed soothingly that the matter was most serious and worthy of their instant consideration. But nothing was done; the mound of rotting coffee remained on the wharf continuing to rot.

Rush was outraged. He felt like the prophets of old who had predicted destruction and who had been ignored. He thought of Cassandra, who foretold the future but whom no one believed. He went to the people of Philadelphia, he spoke to everyone he met and he crossed the street to confront those who would avoid him. He wrote to the newspapers. Everyone listened politely, the newspapers carefully printed each of his letters—but the coffee remained on the wharf.

The citizens of Philadelphia were not impressed by Rush's theory of smells and yellow fever—the smells had always been strong and in great variety in Philadelphia had confidence in other means. They tie little bags of tar or camphor around their necks, sprinkled vinegar and pennyroyal on their pillows and whitewashed the walls of their homes, fired gunpowder from muskets and cannon, chewed garlic and smoked continuously, even women and small children puffing steadily at large cigars. Daffey's Elixir was a favoured remedy; it was nearly pure alcohol and it protected adequately against the fear of yellow fever.

Then a letter to the editor of one of the newspapers noted that ever since it had been dumped on the wharf, many poor folk had been pilfering the coffee. They had been removing and brewing and drinking large quantities of it, and they lived

without yellow fever, and they were still drinking the brew!

Rush was not crushed; he was offended. He was convinced that one of his many enemies had written the letter. He believed the entire affair had been put up to torment him and he felt an angry contempt for the miserable people who had imbibed the deadly coffee and who continued to remain alive and free of yellow fever. But afterwards he referred less frequently to rotten coffee and more to "morbid atmosphere" as the cause of yellow fever.

Meanwhile he continued to visit his patients, and he continued to think about yellow fever. As he suffered in the heat and brushed away the mosquitoes that buzzed about his head, suddenly it came over Rush all at once—a second revelation! To treat yellow fever, he should not attempt to strengthen the body; he should weaken it until the body would be too feeble to support a fever, and then, having nothing on which to feed, the fever would leave! Suddenly he knew that he must purge his patients with the strongest of drugs, let out the blood not in drops but in torrents!

Hastily, Rush ran to his next call, a new patient, and he found a man deserted by his household and dying of yellow fever. He forced open the jaw of the dying man even as it was stiffening in the final convulsion and he forced down his throat an incredible dose of purgative. Then he severed a vein and the blood that was about to coagulate in death flowed out until nearly every drop had been drained. Miraculously the man moved, groaned, sat up and asked for food and drink, inquired about his wife and children and lived for many years thereafter. The name of this Lazarus was never divulged. There were no witnesses; there was only Dr. Rush to tell the story and he told it repeatedly. He told all of his patients, he visited the offices of his fellow practitioners and told them, he stopped strangers and told them, and of course he wrote to the newspapers. He used the treatment that had been revealed to him on all his patients and he spoke and wrote incessantly of his miraculous successes. "I now save twenty-nine out of thirty . . . I lost out of about fifty patients but two, and these I did not see till the third day of the disease. They both moreover refused to submit to several of my prescriptions . . . out of upward of 120 of strongly marked cases, I lost but two—never before did I experience such sublime joy as I now felt in contemplating the success of my remedies." He failed to mention that he never kept any records, and, since the dead could neither speak nor write to the newspapers, there were none to question or disagree. When the deaths of some of his patients were pointedly brought before Rush, he always

said that they had come to him too soon or too late, other doctors had interfered, the nurse had been careless or "the patient had not taken his purge properly."

Rush was shocked when most of the physicians of Philadelphia rejected his treatment for yellow fever. He was outraged when they said of his remedies, "a dose for a horse, a monstrosity of a dose." He was unable to understand how they could reject the truth that had been revealed to him, convinced that the epidemic would end if only the other physicians would acknowledge his remedies, and he prayed that heaven would forgive their sin. "Never before did I witness such a mass of ignorance and wickedness as our profession has exhibited in the course of the present calamity. I almost wish to renounce the name of physician . . . They abound in absurdities and falsehoods . . . Indeed the principal mortality of the disease is now from the doctors . . . Besides combatting with the yellow fever, I have been obliged to contend with the prejudices, fears and falsehoods of several of my brethren, all of which retard the progress of truth and daily cost our city many lives."

He was infuriated when patients refused his treatments and turned to other physicians, and lived. Then he would lament that his methods were being used surreptitiously and he would complain, "They have confederated against me in the most cruel manner and are propagating calumnies against me in every part of the city."

Despite his enemies and his "persecution," Rush continued to "heal" yellow fever. His brisk figure seemed to be everywhere at once in Philadelphia. He had forgotten that other diseases existed; to him all illness had become yellow fever, and all patients were equally and mercilessly purged and bled. In retrospect, the account of his zeal is depressing. No doubt there was yellow fever in Philadelphia in 1793, but was there truly a great epidemic as proclaimed repeatedly by Dr. Rush? Or was there largely death from bleedings and purgings? One tenth of the people of Philadelphia died in 1793, allegedly of yellow fever. Did most of them die actually from the remedies of Dr. Benjamin Rush and his disciples?

Other physicians feared yellow fever and were worried by its mystery and its deadliness. Not Dr. Rush. He failed to see his own dead, seeing only the dead of his fellow practitioners. To his patients he said, "Why, you have nothing but a yellow fever!"

He campaigned publicly by correspondence and by word of mouth; he advertised in the newspapers. He claimed that only he could heal yellow fever—and the terrified citizens of Phila-

delphia flocked to him as to a saviour, begging to be healed. "Having found myself unable to comply with the numerous applications that were made to me, I was obliged to refuse many every day. In riding through the streets I was often forced to resist the entreaties of parents imploring a visit to their children, or of children to their parents. I recollect that I tore myself away at one time from five persons who attempted to stop me, by suddenly whipping my horse and driving my chair as speedily as possible beyond the reach of their cries."

His office could not accommodate his patients. His assistants took the sufferers out into the yard and punctured their veins and let the blood flow on the ground until it became a muddy morass. And his patients, those who miraculously lived, wrote letters of eulogy to him and to the newspapers, and composed poems of praise in his honour.

Gratified with his efforts, Rush set up a small drug factory in his home for mixing his purging powders. He hired assistants and, when the pressure of the business became excessive, he pressed his own sister into service. He arranged with druggists to advertise his remedies. He increased the withdrawing of blood, frequently removing nine pints or more from one patient. He made use of barbers and trained laymen in the art of blood-letting; he also petitioned the city of Philadelphia to provide carriages, that bleeders might move rapidly about the city to bleed everyone.

He compared his remedies with the healing of Christ, and when the opposition grew and his critics became outspoken, he compared their criticism to the persecution of Christ, and he called on Heaven for support. He was a religious man; he belonged to not one but three faiths, Episcopal, Presbyterian and Unitarian, changing back and forth between them as the occasion warranted. He attended prayer frequently and taught his pupils that frequent worship was stimulating to the career of a physician. It gave him a reputation for piety and influence with Heaven, as well as an opportunity to meet prospective patients, he said.

His religious fervour did not interfere with his business acumen. "Between the 8th and 15th of September, I visited and prescribed for between a hundred and a hundred and twenty patients a day." He charged seven shillings sixpence for each bleeding; the purges were extra. Nevertheless, he claimed to be poverty-stricken and through his political influence, which was considerable, he obtained additional income by an appointment as treasurer of the Philadelphia mint, with nominal duties and a salary of \$1,200 annually.

His assistants became ill, he purged and bled them and they died. They died, said Rush, because the nurses had been ignorant and had not followed his prescription. Then his sister became sick; she took his treatment and died. He made no excuse for her death, but he was dispirited for several days after: "On the 1st of October, at two o'clock my sister died . . . My short and imperfect sleep was disturbed with distressing visions and from fitful dreams. The scenes of them were derived altogether from sick rooms and graveyards. The hearse and the grave mingled themselves with every view I took of human affairs."

His mother also became sick, but she refused his treatment and lived. Rush made no comment on her recovery. He continued to "heal" yellow fever.

Whenever the fever took a turn for the better, the patient and Dr. Rush rejoiced; when it terminated in death, Dr. Rush was undismayed. He increased his dosages and his bleedings, he calculated the amount of blood in the human body and he proposed to withdraw four-fifths of it. But his calculations were faulty—he estimated the blood at double its true volume. Dr. Rush attempted to withdraw more blood from the human body than it contained!

Yellow fever ended in Philadelphia in 1793 when the cold weather came, but it returned the next year, and each year thereafter for nearly a decade. During each epidemic, Rush assiduously applied his purges and lancets, and each summer bowels and blood flowed in freshets. And with each epidemic the prestige of Dr. Rush grew brighter, though his patients continued to die and his critics grew ever more caustic.

Encouraged by his success, he broadened the scope of his theory of yellow fever to include all diseases. "There is but one disease in the world," said Rush, and that disease was a fever caused by high blood pressure, to be healed only by the prescription revealed to Dr. Rush. He wrote many medical essays describing his theories, and of them the famed Elisha Bartlett wrote, "It may be safely said that in the whole vast compass of medical literature, there cannot be found an equal number of pages containing a greater amount and variety of utter nonsense and unqualified absurdity." And in recent years, P. M. Ashburn added, "The methods used by this good man [Benjamin Rush], the leader of his profession, were as unethical, unscientific, and as unwise as those of the most arrant quack." But this was many decades later. At the time that Rush wrote his medical essays, every word was sacred, only the Bible receiving more reverence among a group which had formed about him and which rapidly increased as the years passed.

Also, as the years passed, Rush relentlessly ground down and crushed his opposition. One by one his fellow practitioners either submitted or shrank from him in silence. They could not cope with his vitriolic language; he pursued them, ignoring medical ethics and human honesty. He labelled them assassins and branded opposing opinions as "chiefly from itinerant or fugitive doctors, or from a dull and profligate usurer who has not seen a sick man these seven years." He was incensed against the French physicians in Philadelphia—too many of their patients lived on in perfect health—so he complained that they were "equally a stranger to the disease, and to the principles of medicine." Of a respectable and competent fellow physician, Rush had this to say: "It is truly distressing to think of the desolation which has followed the footsteps of this man."

His final adversary was William Cobbett, journalist.

It all began when Cobbett criticised the Rush method of treating yellow fever. Said Cobbett of the Rush treatment, "It was one of those great discoveries which have contributed to the depopulation of the world." Rush had boasted that his remedy was the "Samson of medicine" and Cobbett retorted, "Samson slew his thousands, but the Rushites have slain their tens of thousands." He charged that Rush killed his patients by bleeding, and those that survived somehow sans blood were certain to succumb to his murderous purges. He proved that Rush wrote letters to the newspapers in praise of himself but signed by the names of others. He crowned Rush "the remorseless King of the Bleeders . . . King Quack among quacks . . . Blood, blood," wrote Cobbett, "still they cry, more blood! In every sentence they menace our poor veins."

Rush had silenced his opposition among the medical fraternity, but he could not silence Cobbett nor answer his criticisms. He sued him for libel.

At the trial, Dr. Rush testified that all of his patients survived, and he remained serene when it was shown that he kept no records, not even a list of the names of his patients. Cobbett followed with statistical evidence proving that the death rate from yellow fever had increased wherever the Rush "cure" had been introduced. There was no doubt of the truth of Cobbett's case; his evidence was clear and there were no denials from his opponent. But the influence of Rush in Philadelphia was too strong. The jury found Cobbett guilty. He was fined \$5,000 plus \$3,000 in costs. He was abused, threatened and driven out of the city.

Having disposed of his last critic, now and for the remainder of his lifetime Rush reigned unchallenged. He continued to

write medical treatises and his every word was recorded and treasured. He "healed" epilepsy by drawing blood and extracting teeth. He "cured" insanity and hydrophobia by bleeding alone. He proclaimed that putrid vegetables, old books and paper money gave off noxious vapours which caused disease. He wrote how "morbid atmosphere" changed in quality and quantity with the phases of the moon, and how "due to morbid air, peaches ripened this season three weeks sooner than in ordinary summers and apples much sooner than usual after being gathered in the autumn . . . But," said he, "flannel shirts worn next to the skin will prevent many diseases. Linen when worn long favours the production of lice and pestilential diseases." He published sermons on temperance, and he divided people into two classes, those who should and those who may not drink alcoholic beverages. He attacked the tobacco habit: "Many diseases are produced by the use of tobacco, some of which become fatal." He advocated certain kinds of mineral waters for certain diseases, and he specified the best time of the day at which to drink each of them. He promoted the use of Indian herb remedies, wrote on dreams and their significance and speculated in real estate.

One day he became ill. He was treated by the Rush method and he died.

Dr. Rush had been acclaimed in life, and he was deeply mourned in death. His colleagues and students, his grateful surviving patients, many politicians, statesmen and scholars joined to honour him at his funeral rites. He was "not only an honour to his profession and his country but an ornament to human nature, the benefactor of the human race . . . the greatest physician this country has produced." His friend, John Adams, who had given Rush his sinecure position as treasurer of the Philadelphia mint, wrote, "Rush has not left his equal in America. He has done more good in this world than Franklin or Washington."

Today, Benjamin Rush is still the American Hippocrates. His works rest on the shelves of most medical libraries, his portrait and bust adorn a place of honour wherever medical men congregate. He dominated the practice of medicine in America long after he had been buried. Over three thousand students had passed through his classroom and they spread the gospel of Rush over the nation. Nearly a century of error and death was needed to erase its deadly influence.

CHAPTER XVII

THE INTANGIBLE GERMS
OF CHARON

GERMS OF yellow fever continued to terrorise the people of America, bringing death regularly every summer to the cities on the south Atlantic seaboard and the Gulf Coast from which they penetrated inland. From Philadelphia the germs moved to the north, to New York, and of the epidemic there in 1820 Dr. Joseph Smith wrote, "One hundred and fifty died on Bancker Street of either yellow fever or typhus fever, it was not certain which." Other epidemics came in the years that followed and these the medical practitioners agreed were undeniably yellow fever. The dogma of Benjamin Rush extended in space beyond Philadelphia and in time beyond his tomb, as he continued to dominate the practice of medicine, and from him the New York physicians learn to speak authoritatively of yellow fever and its cause.

Dr. Bayley adhered rigidly to the doctrine of "morbid atmosphere" in its original form as revealed to Benjamin Rush. He disapproved of the deviationists and reprimanded many of his colleagues for their heresy. During the epidemic in New York, he observed "the destructive effects of the constitution of the air upon cabbages, that in that year cherries did not come to perfection and soon showed a disposition to decay. Apples began to fall at least a month before the normal time and in a very imperfect state." These observations confirmed the theories of Rush, said Dr. Bayley; it was another triumph posthumously for that great physician; it proved that "morbid atmosphere" abounded in New York and from it came yellow fever.

Other physicians preferred to describe yellow fever as emanating from the slum areas of the city, from shabby homes and unwashed clothing, from littered streets and alleys and, in particular, from the vile odours that continuously arose from them. Dr. Bartlett reported that yellow fever in New York originated in Peck Slip, "a crowded and most filthy locality. It began at the lower end of John Street where between twenty and thirty persons were suddenly seized with the disease in one night in

consequence of a blast of putrid and most offensive exhalations from the sewer of Burling Slip." Other victims were prostrated by noisome odours from other sources, said Dr. Bartlett, and there were several persons "who were deeply infected by the smell of a foul bed and died shortly afterwards."

Dr. Smith thought otherwise. "There are epidemic influences," he wrote, "which occasionally operate with devastating fury on communities and nations; a good physician should study climate as diligently as medicine; each kind of weather produces its kind of epidemic disease."

Dr. Carey was a radical dissenter; he was convinced that a dissolute life was conducive to yellow fever. He observed that the great epidemic of 1793 in Philadelphia raged most fiercely along the sinful waterfront and decimated the sprightly females who roamed there. "To the *filles de joie*," commented Dr. Carey, "yellow fever has always been most fatal." He concluded that the wages of sin were yellow fever, in Philadelphia certainly and perhaps elsewhere.

They debated heatedly with one another, but they put aside their differences and united in violent opposition to those who dared propose that yellow fever might be perpetuated among men by the germs of disease that Fracastorius had propounded in 1546. Dr. Smith argued vigorously in support of the "incommunicable nature of yellow fever." He predicted that "the dogma which asserts the specific contagiousness of yellow fever, plague, dysentery, typhus and other fevers, will eventually be forgotten, or only remembered as an error of the schools!"

These were the opinions of most physicians at the beginning of the nineteenth century and they remained unchanged over the rest of the century. The influence of Benjamin Rush weakened as the years passed, but the remnants of its power were sufficient to stifle progress in yellow fever research. There was no apparent increase in man's knowledge of yellow fever in the nineteenth century—but the mystery of yellow fever had been solved, only the solution had been disregarded!

First there was Josiah Nott who in 1848 wrote of yellow fever and its connection with insect pests. He had observed that the fevers declined as the weather became cooler and insects disappeared, and he deduced that biting insects, probably mosquitoes, carried the yellow pestilence. A few years later, Beauperthuy made similar observations and concluded that "yellow fever is produced by a venomous fluid injected under the skin by mosquitoes like poison injected by a snake." And there was Finlay who spent many years studying yellow fever and mosquitoes. He correlated the one with the other and even

identified the genus and species of the mosquito. He noted that when *Aedes aegypti* appeared, so did yellow fever, and when *Aedes* left, the epidemic receded and disappeared. By the methods of science, by logic and reason, Finlay proved that yellow fever was a contagious disease spread by the bite of mosquitoes.

Alas for Nott, Beauperrhuy and Finlay, and for the victims of the yellow death! The world of medicine was ruled by a long-dead elderly physician, who in life had moved briskly and peered sharply through gold-rimmed eyeglasses worn on a bony high-bridged nose, who had debated bitterly and written incessantly. A dead zealot intimidated living scientists and physicians; an absurd doctrine refuted science and logic and reason!

The observations of Nott, Beauperrhuy and Finlay were published in the medical journals and there they remained, ignored by most physicians and regarded by others as curiosities of science or as unseemly theories and wild speculations. In 1898, the U.S. Marine Hospital Service Official Bulletin said of yellow fever: "One has not to contend with an organism or germ which may be taken into the body with food or drinks but with an almost inexplicable poison so insidious in its approach and entrance, that no trace is left behind."

As the nineteenth century turned into the twentieth, war and medical science invaded the island of Cuba, and there the riddle of yellow fever began to unravel. The doctrines of Rush had finally worn threadbare, the "morbid atmosphere" theories had expired from inanition. There was now a vacuum of knowledge surrounding yellow fever and into the vacuum filtered vague opinions connecting yellow fever with filth and contamination. No one sponsored such opinions: they seemed to exist of themselves, clinging to the writings and practice of medical science by simple inertia. And there they remained until Dr. William C. Gorgas of the U.S. Army came to Havana.

Havana in 1898 was like Philadelphia of 1793. There were waterfront rooming-houses and wharfs with rotted pilings, sewers and canals, swamps and alleys and markets and shabby dwellings, each with its own kind of refuse and litter, each redolent in its own fashion, and all combined in shimmering emanations distilled violently by the heat of a tropical sun. The odours would have delighted Dr. Rush; he would have hastened to sharpen his lancets and to seek out his most powerful purgative drugs. For in the dirty city of Havana, along with the bad smells, roamed the fever that turns men yellow. It reached into the

shabby homes and plucked life from their miserable occupants, it overflowed the dirty city, oozing into the clean barracks of the American soldiers, and they also burned with fever, turned yellow and died.

Filth and smell and yellow fever did not delight Dr. Gorgas. He roared orders and men in brown uniforms hurried about the dirty smelly city, and suddenly it was a clean city and its air smelled pure and fresh. It was like a miracle—but there it ended. There was not less yellow fever, nor was there more; it was just as it had been before Dr. Gorgas had roared his orders. Cubans and Americans continued to die of yellow fever in the immaculate and odourless city of Havana.

In science research, a single resounding No! is frequently worth more than a thousand trivial positives. Dr. Gorgas had removed the last obstacle to the complete understanding of yellow fever. He had with finality laid the ghost of Dr. Benjamin Rush and restored the vacuum around yellow fever. All this was well, but yellow fever still remained in Havana and Dr. Gorgas appealed for help. He sent a message to Washington, D.C., and Washington sent him a Commission.

The commissioners, having no filth or contamination to contend with, were assigned to fill in the clean vacuum that now surrounded yellow fever. They had to contend only with the yellow fever germs. They knew that at any moment their research might draw each of them deeply into the very sickness and death they had come to study.

Yellow fever experiments are always dangerous, for it is an unpredictable disease and the germs have many painful surprises for those who venture into their realm. Sometimes, when the germs have been injected into the body, they arouse a trivial fever that ends soon and is soon forgotten. Those who have been visited with such *mild* yellow fever are fortunate, for they are immune forever to yellow fever of any degree of virulence. At other times, yellow fever announces itself ominously with racking pains, by collapse and delirium. Then days and nights pass as a burning fever continues without relief and exhausts the diseased body. The skin and eyes turn yellow, blood flows from the mouth and internally from the stomach. The heart falters, its beat weakens and fades and death enters softly. This was the disease the Commission came to study.

The Yellow Fever Commission was composed of Walter Reed, chairman, Aristides Agramonte, James Carroll and Jesse W. Lazear, and they studied the disease for two years. They solved the problem to which they had been assigned—they proved that yellow fever is caused by a virus and carried by

mosquitoes, but before their work was done, half of the commissioners had been claimed as sacrifices to the deadly germs. First Dr. Lazear was infected and he died within a few days. Then Dr. Carroll was bitten by a germ-laden mosquito and, though he survived yellow fever, he never fully recovered his health and he succumbed a few years later. Dr. Reed lived because he was the chairman and could not be spared; he was an unwilling and protesting exile from the experimental laboratories, forcibly excluded from its yellow dangers. And Dr. Agramonte lived because he was not proper experimental material; he had been made immune by the yellow fever he had survived several years before.

These were not the only sacrifices among those who dared to track down the yellow fever mosquitoes in Cuba or elsewhere, or among the volunteers who tested the deadliness of the germs. There were many others. The renowned Dr. Hideyo Noguchi had gone to Africa, sent by the Rockefeller Institute to hunt for the germs of yellow fever, and somehow he had made an error; the quarry that he had painstakingly trailed and caught and brought back to America turned out to be the wrong germs. Afterwards there were heated disputes and recriminations in scientific circles. With troubled mind and sickness of spirit, Noguchi returned to Africa to take up the trail again. His search was interrupted; he never returned to America and the Rockefeller Institute, for the germs of yellow fever intervened and ended his work and his life. The studies of others also were interrupted. Some were victims of accidental infections, some acquired the disease in an unknown manner and some deliberately allowed themselves to become infected. Many of them died. There were Adrian Stokes and Theodore Hayne, Alexander Young, Paul Lewis, and Clara Louise Maass; there were many others too many to be listed—scientists, physicians, nurses, orderlies, soldiers and anonymous civilians—whose obscure graves are evidence of the treachery and deadliness of yellow fever germs.

The results of their work and their death are well known. Yellow fever research has become legendary and is described fully in many textbooks of bacteriology. It is now known that the disease is caused by "small" viruses that are carried only by the *Aedes aegypti* species of mosquito and only by the female of the species. The male stings with a soft proboscis that cannot penetrate the human skin; the male *Aedes* is necessarily a vegetarian. These mosquitoes live in close association with humans. They do not breed in the fields and forests, but in buckets, tin cans, bottles, ditches, canals, rain barrels cisterns or anything

in the vicinity of man that may hold water and mosquito eggs larvae. On the sailing ships of the past, the kegs of drinking water provided breeding places and mosquitoes and germs sailed over all the world.

The mosquitoes perpetuate yellow fever, but they do not create it. They merely transfer germs from diseased humans to healthy humans. If there is no disease, the bite of *Aedes* is harmless. Once begun, yellow fever cannot be healed and its illness cannot be lessened by any means known to contemporary science. But it can be prevented.

At the Rockefeller institute, Dr. Max Theiler searched many years for a way of making men immune to yellow fever, and from the search came vaccine 17-D. It is a living culture of germs of yellow fever from which the deadliness has been removed. When 17-D is injected into the human skin, immunity to yellow fever follows and the immunity remains for at least five years.

Another search has been carried on for a means of exterminating the *Aedes aegypti* mosquitoes. They keep yellow fever alive by transferring the germs repeatedly to fresh human bodies. If the mosquitoes could be made extinct, then yellow fever would disappear and there would be no need for vaccine 17-D. But it has proved impossible to exterminate the mosquitoes. Their numbers lessen as anti-mosquito campaigns begin, but when the campaign is over they seem to breed more rapidly and soon regain their numbers and continue to disseminate yellow fever.

The simplest way to prevent yellow fever is to separate the germs from the mosquitoes by enclosing the sickbeds of yellow-fever patients within fine-meshed screens. Then the germs are confined within the diseased body and *Aedes* can find no germs to carry. Then, though *Aedes* may buzz and bite like other species of mosquitoes, they are harmless. In this manner yellow fever was made to disappear from Cuba and Panama and from the entire coast of Central and South America. It was believed that the entire Western Hemisphere had been made forever free of yellow fever. In *Microbe Hunters*, Paul de Kruif wrote fervently, "In 1926, there is hardly enough of the poison of yellow fever left in the world to put on the points of six pins; in a few years there may not be a single speck of that virus left on earth—it will be as completely extinct as the dinosaurs—unless there is a catch in the fine gruesome experiments of Reed."

De Kruif overflowed with enthusiasm because he loves men and their great deeds; he magnified the power of men and minimised the powers of nature. There was no catch in the experi-

ments of Walter Reed, and the yellow fever martyrs had not offered up their lives in heroic futility. They had all done everything that could be done or should have been done; no one since has come forward to point out how they could have done more or better. But nature has not planned that the germs of yellow fever should become extinct, but has decided that this species of life should continue to exist despite the best efforts of the human science of the twentieth century.

In Panama in 1903 Gorgas announced triumphantly that the last case of yellow fever had been discharged from the hospital. Henceforth there would be no more yellow fever in Panama, said Gorgas, but Gorgas was wrong! Like De Kruif later, Gorgas underestimated the power of mother nature. Unobtrusively, imperceptibly, year after year, the germs returned, multiplied their numbers and continued to increase, until fifty years later the devils of yellow fever exorcised by Gorgas returned to full dominance in Panama. And in Rio de Janeiro, where Oswaldo Cruz had exterminated the germs in 1909, yellow fever reappeared. A few at first, then more and more Rio de Janeiroans sickened and turned yellow, vomited black and died, and in the year 1938 the numbers of yellow fever cases were as before 1909.

It was learned then that the germs of yellow fever may never be exterminated, unless it becomes possible to destroy all of the wild animal life of Central and South America and Africa. For, at some unknown date in the past, the germs infected the wild jungle monkeys and were transported from monkey to monkey by jungle mosquitoes. Among monkeys, yellow fever is mild; nearly all of them live, and the germs remain virulent within them. When men enter the jungle, the jungle mosquitoes bring the germs from monkeys to men, and when the monkeys raid the plantations, plantation mosquitoes become the carriers. From the jungles of Central and South America and Africa, germs of yellow fever slowly creep into the centres of civilisation, where men replace monkeys as hosts. Though yellow fever is eliminated time and time again in civilised areas, jungle yellow fever remains always ready to turn into civilised yellow fever. The germs find a permanent haven in the monkeys, and, should the monkeys be destroyed, other animals will serve the purpose of nature—scientists have already found that marmosets and hedgehogs harbour the germs when monkeys are scarce. As long as there are jungles and wild animals and mosquitoes, the germs of yellow fever will survive.

CHAPTER XVIII

THE GERMS OF HUMAN MISERY

WHEREVER UNWASHED humans congregate in dense masses, wherever clothing is neither changed nor laundered, wherever the reek of stale sweat pervades, there the human louse appears. The germs of typhus soon follow and the combination of men, lice and germs breeds an epidemic of typhus fever. Once a human has acquired the disease, his misery is soon shared by others. Lice, having no sense of allegiance to the individual whom they inhabit, crawl from one host to another without discrimination. Invariably they leave when the human body, burning with the fever of typhus, becomes too warm for their comfort; inevitably they depart when the human body grows cold in death. Then pestilence crawls from one body to another and epidemic typhus fever begins.

Unwashed bodies joined with lice and germs to create typhus fever during the very early history of mankind. The germs of typhus probably arose in the bleak lands of Siberia and invaded the Siberian tick, which in turn infested the suslik, or Siberian marmot; then many years after, when men were evolved, the germs transferred from the tick to the louse and so to men, and typhus fever was created. And ever since then the germs of typhus fever have always accompanied men in their misery and misfortune, crawling in the wake of famines, sieges, wars, floods and other disasters.

The germs ravaged populations long before the symptoms of the disease were recorded in 1083 at the monastery of La Cava overlooking the town of Cava near Salerno. But because of the inadequacies of medical diagnosis in early Europe, our formal knowledge of typhus begins in the Middle Ages, a most flourishing period for lice and for typhus fever.

The human lice of medieval times suffered no lack of facilities conducive to their fecundity; in fact, lice were the accepted mode of the period. Lice, like most humans of that era, were born on squalor and poverty, but they frequently migrated. They foraged as vigorously in the powdered wigs of the nobility as in the unkempt natural hair on the bowed heads of the humblest vassals; they did not discriminate between the purple

and gold-embroidered silken garments worn layer on layer and the single ragged shift of the homeless beggar. Among patricians and plebeians alike, overgarments and undergarments were changed only when incredibly filthy or completely worn out. Garments were customarily handed down to others with lice intact, and many a beggar was proud to wear a garment that had once embraced a great lord, to be bitten by the very lice that may have fed on the royal blood of the king himself.

The bathing customs of Greece and Rome had been forgotten and left behind in history. It required a most ripe quality of body stench to attract notice in those days of overworked and calloused nostrils, and strong odours of musk were employed generously in perfumes and toilet waters to overpower the reek.

Everybody had lice in the Middle Ages, everybody stank, and everybody itched. Tudor ladies were habitual users of long-handled curry-combs for an itch on the small of the back which their servants could not locate satisfactorily. Writers of the period commented from varying viewpoints, and with divergent interpretations, on the lice departing in orderly files from the bodies of famous men whose dead clay had been placed on view. The more illustrious the clay, the more spectacular the display of lice hastening toward the nearest exit. Eminent men were customarily wealthy men, and the wealthy were frequently not only corpulent but they affected multiple layers of garments which, instead of being changed, had new garments added periodically. The pauper who died in his lone sack-like garment gave a poor show; there was less room for lice in his scanty garb and small attraction for lice in his scrawny body.

The most fertile ground for typhus was in the jails of the period. These were private enterprises run for profit and operated as economically as possible. Prisoners, justly or unjustly accused, spent years in a common dungeon before coming to trial, allowing ample opportunity for an exhaustive exchange of lice. Frequently those prisoners who had not quite died of typhus exacted a measure of retribution when they were finally brought to trial. The jailfare-starved lice were able to migrate and fatten upon juicier bodies while medieval justice was being done, and "gaol fever" frequently disposed of the prisoner, his judges, jury, lawyers for both sides, witnesses and spectators alike with dispassionate impartiality.

In England these sessions of law mingled with typhus fever became renowned as the "Black Assizes," the colour describing neither the garments nor the harshness of English justice but the dark shadow of typhus. The first of the "Black Assizes" was convened in Oxford in 1577. The prisoner, Rowland Jencks,

bookbinder and ardent Roman Catholic, stood trial before the bar, accused of treason and of profaning the Protestant religion. Jencks was found guilty as charged and punished with due process of law, and shortly afterward death from the bite of a louse came to the Chief Baron or the Exchequer, the Sergeant-at-Law, two sheriffs, one knight, five justices of the peace and most of the jury participating at Jencks' trial. From the courtroom, "gaol fever" crawled into the town of Oxford and there fomented disease and panic and clamour. It was either a "diabolical machination of the papists," or a "miraculous judgment against his judges," who had sentenced Jencks to be deprived of his ears. A few of the townspeople thought that "the infection arose from the nasty pestilential smell of the prisoners," but most folk paid them scant heed, for foul odours were commonplace in Oxford. Within a few weeks, most of the population had been prostrated by typhus fever and several hundred perished. Rowland Jencks lived and, though discomfited by the loss of his ears, he survived for thirty-three years after his disastrous assize.

This, the first of the "Black Assizes," was followed by five others, and the last one culminated sensationally in the Old Bailey of London, the toll of victims including the Lord Mayor and an illustrious alderman, two judges, an undersheriff, the jury and many lesser court attaches. Nor was "gaol fever" confined only to England, for "Black Assizes" of lesser fame and known by other names convened in Dublin, Rheims and Strasbourg. A Japanese "Black Assize" was held in 1881, when typhus fever spread from the prisoners to the courtroom and out over the entire city of Tokyo.

Typhus fever came to Spain in 1489 as the troops of Ferdinand were besieging Granada and was familiarly called *el tabardillo*, or little cloak, fancifully describing the skin of dark purple spots in which the victims of typhus found themselves clothed. Germs of typhus fever destroyed seventeen thousand Spanish soldiers, or six times the number killed by the Moors. And when typhus returned to Spain with greater violence in 1606, that year became known as *año de los tabardillos*.

As "military fever," typhus decimated the army of Maximilian II in 1566, though his soldiers knew it as the "Hungarian Disease" and referred to Hungary as the "Cemetery of the Germans." Fifty years later, the Bavarian army in Bohemia lost twenty thousand men to typhus fever and they called it the "Bohemian Disease."

Typhus was also known as "ship fever," "hospital fever" and "famine fever." Murchison has listed a hundred names once

used to describe typhus fever, but in most parts of medieval Europe it was simply the "flea-bite disease," named after the hæmorrhagic spots that resembled insect bites. It is indeed strange that, having described the disease in this manner, it never occurred to anyone in the Age of Itching that the ubiquitous lice might spread the disease. Early in the seventeenth century, Tobias Coberus had timidly hazarded the idea of a relation between typhus fever and lice; his suggestion was regarded as the fantastic theory of a madman. In the nineteenth century, it was believed that typhus was a kind of poisoning, and Hirsch noted "the great tenacity with which the poison (of typhus) clings to linen or clothes, the walls of rooms, furniture, and the like"; and Hecker observed that "woollen clothes retain the poisons of typhus most tenaciously of all materials," both men overlooking the lice that undoubtedly were then swarming over the very objects they were examining.

The first typhus epidemic in Spain preceded the discovery of the New World by a few years, allowing time for the germs to thrive and multiply and supply Spanish adventurers with additional gifts for the Indians of the New World. In exchange for gold and silver, the natives received malaria, dysentery, smallpox, tuberculosis, leprosy and plague, and the germs of typhus collaborated with these in shielding the natives from the problem of Malthusian over-population. From Spain to America in the sixteenth century sailed gifts of lice and germs, and typhus fever erupted in the land of the Aztecs. The total number destroyed by typhus is not recorded, but in 1576 it was noted that two million died.

The Spanish gifts were durable and have lasted for centuries. *Matlalzahuatl* in Mexico was vernacular for typhus fever, later *tabardillo* described the typhus that covers its victims with the spotted cloak and is still used to describe typhus in Mexico and Central and South America.

The Indians of Mexico somehow survived typhus, but others native to the New World did not. In the autumn of 1746, the French fleet of Duc d'Anville anchored off Halifax after a disastrous voyage. Typhus had broken out midway across the Atlantic and had raged for days, each day finding its toll of bodies tossed into the ocean. The ships made for shore for water and fresh food, and to recuperate from the terror of pestilence and death. As winter began, the French fleet sailed away, leaving on shore the garments and blankets taken from those whose spotted bodies were resting quietly at the bottom of the Atlantic. The Indians of the Micmac tribe picked up the discarded clothing and brought it to their homes. It was a long harsh winter with

much snow and nothing is known of the dreadful events in the village of the Micmacs. When Englishmen visited Nova Scotia the following summer, they found the huts of the Indians tenanted solely by corpses and skeletons.

As Europe emerged from the Middle Ages, typhus was not left behind, although unwashed bodies and dirty garments were fewer as soap and hot water replaced musk and attar of roses. But the germs of typhus clung desperately to existence through the poverty and famine of men in lands where soap and hot water were luxuries, as in Ireland. The first recorded Irish epidemic of typhus may have taken place in 1708, but the "Irish Ague" had been known many years before; crop failures and starvation were chronic in Ireland and the Irish Ague invariably followed. Great epidemics of typhus devastated the Irish in 1797, 1816 and 1846. Englishmen and Scotsmen as well as Irishmen died, for the germs invaded England and Scotland, riding on the lice of the Irishmen fleeing the hard times and typhus fever of their homes. And at each period of famine in Ireland, the Irish Ague was exported regularly to America.

In feast or famine, in days of plenty or years of privation, the gods of war are always well nourished. Whenever unwashed men in gaudy unwashed uniforms crowded together in the many armies of Europe, lice and germs thrived and typhus became "camp fever." In an interminable series of European wars, the germs of typhus intervened and participated as actively as any of the human protagonists.

The Thirty Years' War began in Bohemia in 1618, and before it ended, many armies had marched and countermarched over all of Central Europe. The war started with a contest for the Bohemian throne between the Protestant Union and the Catholic League; it was waged with each army in turn killing, plundering and ravaging, and with the most bestial outrages committed by each side against defenceless old men, women and children. As the war progressed, sides were changed frequently, there were treacheries, perfidies and assassinations, but the carnage continued undiminished, and the conflict spread until most of the petty rulers of the petty nations of Central Europe had joined in the slaughter and destruction. The war finally ended. Then in full virulence came the germs of typhus fever. There was little left for the germs; they could not match the ferocity of men. But they gleaned among the souls that men in bloodstained gaudy uniforms had overlooked. Many villages were left devoid of human life and, in some, "in the morning many dead bodies would be found lying in the streets and in front of houses to be

swept away like so much refuse." The Thirty Years' War ended in 1648, and it is said that one could wander over the countryside and walk for miles in any direction yet see no living soul, only the unburied dead of typhus, their spotted corpses serving as carrion for wild animals.

Meanwhile, in 1643 in England, typhus had attacked impartially the armies of both Essex and Charles I, and in five years had spread throughout the land, to serve as a pestilential prelude to the Great Plague that was soon to follow.

In 1812, many soldiers of the Grand Army of France marched to the east; in 1813 some returned. And in between their departure and their return was enacted an epic of death, not by gunfire or swords or lances, but by the germs of typhus fever. The germs were far more formidable than the Russians or the bitter Russian winter. Many historians have related movingly how, as the weather grew colder, soldiers huddled closer to seek each other's warmth, and typhus waxed as the Grand Army waned. The soldiers of Napoleon, despite hardship and typhus, reached Moscow, and then fled from Moscow back to Smolensk, across the Berezina, to Vilna, with the lice and germs of typhus keeping pace and whittling at their ranks as they retreated. The trail of flight was marked with death; the bare ground was both hospital and graveyard; on every meadow, behind every bush, under each tree lay the dead and dying men. Then the Russians attacked and took many prisoners, and with them they captured the lice and germs of typhus. Now Russian soldiers in turn began to sicken and die of typhus fever. Scattered all along the long line of retreat from Moscow lay the bodies of fallen grenadiers; the peasants and townsfolk stripped the garments from the dead for use by the living, and the people of Russia and Poland died as typhus crawled among them. The remnants of the Grand Army crossed the Niemen, wagonloads of dead and dying outnumbering the soldiers that limped wearily homeward—and typhus was dispersed among the people of Germany. The Grand Army finally reached France, exhausted and diseased; less than three thousand returned of the four hundred and fifty thousand that had gaily set out for Moscow.

The Napoleonic campaigns carried war into the Iberian Peninsula, and in the six years of the Peninsular War the French Army lost one hundred thousand men to the enemy, three times more to the germs of typhus fever.

Of the siege of Torgau, Prussia, in 1813, Drs. Lehmann and Richter reported "patients piled like lumber on bare ground, not even straw . . . in order to reach the sick it was necessary to

wade through and climb over dead bodies . . ." At the siege of Mayenne in that same year, Dr. Kerckhoffs was shocked: "I found the living and the dead scattered lying on top of one another. I was obliged to pick my way on tip-toe in order not to sink up to the ankles in filth." And Dr. Wittmann noted that "thousands of dead bodies lay for weeks piled up like logs, awaiting burial."

Wars and typhus continued among men. On the battlefields before Sevastopol in the Crimean War, Englishmen and Frenchmen perished by thousands, and an uncounted number of Russians. All died from the germs of typhus, and a few years later, when war was again declared between Russia and Turkey, the Czar's entire army of the Caucasus was virtually exterminated, not by shot or steel, but by germs of typhus.

World War I arrived and introduced modern methods of more efficient destruction of humans; the age-old methods of the germs of typhus fever remained unchanged.

Early in the war, Serbia was eliminated from active participation, not through military reverses, but by lice and germs. There, in a population of five million, one hundred and fifty thousand died of typhus within six months. There were only three hundred and fifty physicians in all of Serbia, and in a few weeks typhus had exterminated half of them. Lice and germs swarmed over the Serbians and their Austrian prisoners of war; they were disease-saturated. Attendants and nurses were scarce, and they died faster than they could be replaced. Hospitals were improvised from barns, sheds and cellars, on fields with or without a flimsy tent to cover the bare ground, and, when the overworked attending physician lifted a blanket, he saw long-dead corpses lying among the near dead and the living.

Then, amid disease and death and the despair of war, a miracle of humanity blossomed. The fierce Serbian soldiers freely gave their barrack beds to the Austrian prisoners in the overcrowded "hospitals," and themselves slept upon the uncovered ground. One act of humanity begat another, war and the hatreds of centuries were forgotten in the common tragedy of pestilence, and the Austrian prisoners volunteered to serve as attendants and nurses to the sick. All the volunteers sickened and as they died others replaced those who fell, and so they continued to serve and to sicken and die until none was left.

Everywhere over the land of Serbia were the lice and their invisible riders; from army camp and hospital they crawled and spread among the villages and towns. Of the epidemics of the Dark Ages it has been said that, when pestilence descended, humans lost their humanity, husbands fled from wives, mothers

abandoned children and children their parents. But it was not true of the Serbians, nor of their Austrian prisoners. As they died, they retained their humaneness; all confronted typhus and death with stoic calm.

Typhus moved on from Serbia to Poland, but there, where the repeated outrages of war had become commonplace, death by pestilence had lost its terror. Though typhus killed thousands, it created little disturbance in a land where millions had died of war wounds and starvation, over which the tidal wave of warfare had passed and shattered all that impeded it. When typhus appeared in 1916, the peasants of Poland met the new disaster with resignation and fatalism as had their forebears a century before. They removed the clothes from those who no longer had need of clothing and gave them to those who had, and so the germs of typhus fever spread and covered all the wretched land.

World War I ended, and lice and germs clung to man and followed him over the threshold of modern times into contemporary history. World War II created epidemics of typhus fever in Cairo, Naples and Poland, in the Yugoslavian army and the concentration camps of the Nazis. And the recent military campaigns in the Far East have already given birth to typhus in North Korea.

In the past, typhus and typhoid fever were believed to be two different overlapping phases of the same disease, both called typhus fever, and not until 1837 were the symptoms and diagnoses of the two diseases definitely separated. Possibly because the discovery had to be credited to an American physician or because of extreme conservativeness, the medical profession of Europe was slow to accept the change, and even today in some parts of Europe typhoid fever is still described as *typhus abdominalis*, while typhus fever itself is known by the impressive designation of *typhus exanthematicus*. The British medical fraternity was particularly obdurate and reluctantly accepted the distinction long after the French had capitulated. Modern English writers have since risen to defend their compatriots, pointing out that the English physician was neither dull nor stubborn, that the French had the advantage, since at that time France was supplied with plenty of both diseases whereas England had little of either.

Much more has been learned recently about typhus fever. The germs of typhus have been discovered, and it has been found that they are no kinder to the louse than bubonic plague is to the flea; as the lice carry the germs from man to man, they

suffer severely—typhus fever is more deadly to the louse than to the human.

It is difficult to elicit symptoms of illness from a louse, and the course of typhus infection in lice is unknown other than that they invariably die of it. Soon after becoming infected from other lice or from infected humans, the louse lives only long enough to contaminate neighbouring lice and to bite and transmit the disease to its human host. After the louse has bitten, there is a latent period of time, the louse which has passed on the disease passes on, and the bite itself is forgotten.

One to three weeks later it is brought back to the attention of the human host, the germs having multiplied to reach vital organs. Suddenly the victim collapses with burning fever and teeth-chattering chills, lying where he has fallen as though paralysed, his strength gone, unable to do more than make feeble motions with his head and limbs. Worst of all is the continuing throbbing headache that becomes acute torture at his slightest movement. His forehead is contracted with agony in the "wrinkled brow" of typhus, his heart beats in irregular starts and stops, his blood pressure rises and falls erratically while blood gushes from his nose. His mouth is dry, and his tongue dark, hard and cracked like the beak of a parrot, his breath and sweat and bed have the musty reek of a medieval jail. His headache steadily increases in intensity until mercifully the anaesthetics of nature, delirium and unconsciousness, descend and he is unaware of the passing of time. If he is to become a survivor of typhus fever, he will awaken in two weeks.

In his unconsciousness, his muscles twitch and his hands and feet move aimlessly in response to the unbearable pain and nightmare images from which his unconsciousness has been disconnected but to which his inert body responds automatically. His disembodied brain is tortured by obsessions and frustrations, and sometimes his body responds to the insane brain and is no longer inert. Hecker writes of those who, impelled by typhus, have cut their throats, beaten themselves with hammers, flung themselves from windows and attempted to amputate those parts of the body that offended them in the distorted world of violence and outrage in which their brain lived. He also writes of the battlefields of the Crimea where it was commonplace to see French soldiers escaped from hospital beds and wandering over the fields, some muttering quietly, others shouting with frenzied hoarsened voices, all insanely ignoring the guns and shells of the battlefield and the sane humans about them sanely intent upon destroying one another.

There is a week of madness, and typhus fever has not yet run

its course. The next phase arrives, and pink spots cover the body, turning to red, then to dark purple. The heart weakens, the lungs cough in convulsive fits, hands and feet become as blue and cold as those of a corpse and frequently as dead, if gangrene sets in. This, after two weeks of siege, is the crisis. If the victim lives after the crisis, he needs two more weeks in bed before his mind clears and he ceases to wander in the land of nightmares, before the coughs become fewer and the headaches change into ordinary dull pain. Then he need no longer fear typhus fever; he has become immune.

The germs and lice of typhus fever are not extinct; they continue to thrive among the under-privileged people of the world. They crawl and infect in Mexico, Central America and South America, the Balkans, the Near East, northern China and North Africa.

In the United States, germs and lice have only a precarious foothold, although they have invaded the coastal cities again and again. They were imported repeatedly from Europe. The infamous ship *Eutaw* from Liverpool and the infested barque *Barlow* from Greenock brought Irish emigrants, all with lice and many with the germs of typhus fever, to New York in 1842. Ships of lesser infamy sailed from other ports of Europe, from Poland, Russia, the Balkans, arriving continuously in America. There were notorious epidemics of typhus fever in New York in 1881 and 1892 and in Philadelphia in 1883. Another wave of lice and germ-infested peoples fled the poverty and wretchedness of Europe in 1921, bringing pestilence again to the shores of America. The lice and the germs never became firmly established here, tending to die out in a civilisation hostile to them. But they are not extinct. They still lurk in the gloom of jails and asylums, hospitals and institutions and hide in the squalid tenements of the larger cities. They remain latent everywhere. Sometimes nature stirs up the scourge of typhus fever with floods, earthquakes, fires and famines; more frequently man himself distils typhus fever from ignorance; poverty and filth and, most frequently of all, the disasters of war.

In earlier days, alcohol in wines and hard spirits was the only known treatment for typhus fever. In recent years the newer miracle drugs have proved to be useful though not miraculous against typhus, and vaccines have been successful in the prevention of the disease. In the practical and long-range view, drugs and vaccines are less valuable than soap, hot water, and delousing powder. Typhus fever remains, as in the past, a "self-terminating" disease; it does not pass from man to man, but from

man to louse to man. The human louse must live solely on humans, on no other animal will it survive. Once the louse has been exterminated, the essential link in the sequence is broken, and when the last human louse on earth is gone the existing patients with typhus fever will be the final cases on earth—the human louse having become extinct, the germs of typhus fever will likewise become extinct.

CHAPTER XIX

THE ASPIRING GERMS

THIS BEGINS as a familiar tale. A scientist studies a virulent disease, finds the germ that causes it, becomes infected and dies of the germs he has discovered.

Now, scientists are mortal human beings and they cannot evade death despite their science. Whether they die of the germs they have discovered, or of some other species of germs, or of the ailments of old age or in a traffic accident is ordinarily immaterial. But in this case, many profound developments followed the comparatively simple discovery of the germs of typhus fever and it is a pity that Ricketts and Prowazek did not live to see them.

Dr. Howard Taylor Ricketts could have remained among his own people. He was a physician and could have practised general medicine or some speciality, benefiting his community and at the same time becoming wealthy. Instead he was impractical and stayed poor; he studied bacteriology and did research on the unpredictable disease known as Rocky Mountain Spotted Fever. He could have continued his research in the United States, but he was obsessed—some scientists are—that is what makes them great. Dr. Ricketts was obsessed by typhus fever. So he did something even more foolhardy from the practical view—he went to Mexico where typhus fever is always to be found.

Typhus fever is much more predictable than Rocky Mountain Spotted Fever. Rocky Mountain Spotted Fever is sometimes dangerous and sometimes mild; typhus fever is always dangerous.

Of all the diseases for physicians to study, typhus fever is the one they should select last! For some strange and unknown reason, typhus seems to be most deadly among physicians. When-

ever patients, nurses and physicians are all infected with typhus fever at the same time in the same hospital, ten per cent of the patients may die and perhaps twenty per cent of the nurses, but fifty per cent or more of the physicians always die. Ricketts knew all this. He also knew that it takes just one bite from one louse—the French bacteriologist Dr. Nicolle had proved that a few years ago during the great typhus epidemic in North Africa. But Ricketts went among the patients in the Mexican hospitals, among patients who were overflowing with lice and the as yet undiscovered germs of typhus fever.

He searched patiently for the germs, much more patiently than any of the previous searchers, and he found them! No wonder the other searchers had failed, they are so very small, almost invisible dots under the highest power lens of the best microscope. Even the great Nicolle had overlooked them.

Ricketts found the germs of typhus fever, isolated and cultured them, and then he must have been bitten by an infected louse, for he caught typhus fever and died. He was not quite forty years of age.

In Serbia, another impractical man named Stanislas Josef Mathias von Prowazek studied typhus fever instead of practising medicine. He also was bitten by a germ-laden louse—there is no other way of getting typhus fever—and he died. He also was not quite forty years of age.

Two great pioneers in bacteriology and typhus fever, two brave unself-seeking men were both dead within a short period of time.

Their colleagues all over the world mourned sincerely. Scientists really are mild and sentimental humans; the infamous mad scientist of fiction who seeks to conquer the world simply does not and cannot exist. For scientists, a laboratory is sufficient, with perhaps a few honours. What more could they need? Why ever in the world would a scientist want to conquer the world? Whatever in the world would he do with the fool thing after he had conquered it?

Their colleagues could think of no better tribute than to name the germs of typhus fever after Ricketts and Prowazek. That is why the germs that Ricketts discovered are described collectively as the "germs of Ricketts" or Rickettsia, and the germs of typhus fever specifically have since been known as *Rickettsia prowazekii*.

The story of Ricketts and Prowazek ended and the story of the germs began. The story of Rickettsia really began many millions of years in the past and the ending lies in the future where we cannot peer. It is a strange story of germs and men

and lower animals. There are many varieties of the Rickettsia and each of them causes a kind of typhus fever. Some are deadly, but most are mild. They all cause fever and headache and usually spots on the skin. They all live on rats or mice or cattle, or on the furry animals of the fields and forests, and all are carried to human beings by lice or ticks or mites or fleas. There is no other way of infection. Nature so devised it that these germs climb up toward man by means of the lower animals. Only European Typhus Fever and Q Fever are exceptions; again by nature's planning, they have evolved partly beyond the need to live on lower animals.

Various kinds of Rickettsia are found all over the world and a narrative of encyclopædic proportions would be needed to do full justice to their number and variety. There are certain species that live in Mexico, Russia, parts of Africa, Greece, Manchuria, Malaya, Indo-China, Syria, Chile and Peru. These germs are found in rats and in their fleas. They harm neither the rats nor the fleas but sometimes they are carried to man by flea-bites and then man suffers from Rat Typhus Fever.

In Japan, there is another kind of typhus; the Japanese call it "Tsutsugamushi" Fever. The Japanese field mice that live along the rivers carry the germs, and tiny bloodsucking mites that live on the mice transfer the germs to men. Neither mites nor germs make any distinction between races of men or between their ethnic and national extraction. Japanese mites bit the soldiers of the American and British armies and injected the Japanese variety of Rickettsia, which caused a disease almost as dangerous as European typhus fever. It was Tsutsugamushi Fever that killed American and British soldiers in Japan, but the American and British medical journals called it Scrub Typhus.

India has its Indian Tick Typhus and Australia its North Queensland Tick Fever, and both diseases are spread by ugly bloodsucking ticks that take germs from infected cattle and carry them to the men who tend the cattle.

In the French colonies of North Africa, stray dogs roam everywhere. And both in the dogs and in the ticks that infest them is a particular species of Rickettsia. When the ticks bite and suck blood from men, they pass on these germs and cause Boutonneuse Fever.

In the interior of Africa are other kinds of ticks and two kinds of Rickettsia. They live on the wild game of the plains, and, when hunters and explorers enter the game country, they risk infection with South African Tick-Bite Fever or with Kenya Fever.

In Russia, a species of *Rickettsia* rides on the Siberian tick which sucks blood from the Siberian marmot. When marmots are scarce and man available, then the ticks suck man's blood and give him the germs of Siberian Tick Typhus Fever.

In Mexico there is Choix Fever; in Colombia, Tobia Fever; in Brazil, São Paula Typhus and Minas Gerais Fever—there seems to be no end to the number and variety of the germs discovered by Ricketts. Each nation on earth seems to possess its own kinds of the germs and the germs seem to have taken on a sort of nationality suited to the people among whom they thrive.

Only Trench Fever has no nationality. It arose during World War I and spread among the ranks of all the embattled armies on both sides of the Western Front. The germs of Trench Fever disappeared when the war ended, and they are not now to be found anywhere. Unfortunately, no one thought to preserve and culture the germs and store them in test tubes. But it really is not important that cultures be kept; Trench Fever can always be created anew. There is a recipe for it:

Take equal parts of human sweat and blood and spattered flesh and bone and mix with the excrement that comes when men fear instant death. Add to the mud of the battlefields and mould into trenches. Garnish with unwashed men in filthy uniforms. Allow to bake in summer heat or freeze in winter cold and, of a certainty, lice and rats and germs will emerge to recreate Trench Fever.

In the United States, there are many old Indian legends, and some of them tell of evil spirits in the mountains of the West that brought a strange illness and a horrible death to the foolhardy brave who dared enter a certain forbidden valley. When the first white men arrived in Montana, they settled on the land that the Indians avoided and they called it Bitter Root Valley. They found the Indian legends to be true—many of them became sick and feverish, suffered from headache and the spots that broke out all over their bodies. Many died, but the white men refused to be frightened away by Indian legends. They remained in the valley and called the sickness "black measles." Many years later it was renamed Rocky Mountain Spotted Fever. It was this disease that Ricketts had studied before he went to Mexico, and it was in the bodies of its victims that he had first seen the strange germs which were later to bear his name.

After Ricketts had gone, other scientists studied Rocky Mountain Spotted Fever. They discovered the germs in wild rats and

mice, squirrels, rabbits, gophers and deer of the West and in the ticks that bite and suck blood from these animals. When the ticks bite men, then they transfer Rocky Mountain Spotted Fever, an unpredictable disease. In one terrible epidemic at Bitter Root River, nearly all the infected persons died, and among the dead were five scientists from the United States Public Health Service. But in the nearby Snake River Valley epidemic, though they were dangerously ill, nearly all the victims lived.

Then it was discovered that the sickness of the forbidden valley in the West is also found in many parts of the East. There is, for example, a certain place on Long Island, New York, where Teddy Roosevelt's Rough Riders once made their camp. There the germs of Rocky Mountain Spotted Fever abound. They live within the bodies of stray dogs, foxes, raccoons and field mice, and of course in the bloodsucking ticks that infest these animals. Teddy's men had grumbled about the hardships of camp life and complained bitterly of fevers and racking headaches and spots that erupted all over their bodies. They suffered especially from "pale bedbugs" that bit them again and again, and, no matter how often these pests were exterminated from the camp, new ones seemed to arise spontaneously. Many years later, when scientists studied the "pale bedbugs," they found that these ticks were able to smell the odour of human bodies from a long distance. They also found that these ticks prefer human blood to any other kind. When they pick up the scent of man, the ticks leave the dogs, foxes, raccoons and field mice and crawl towards men. Whenever they can, they bite and suck human blood and pass on the germs that cause Rocky Mountain Spotted Fever.

There are other *Rickettsia* that are not native to this country. They are imported from abroad and they adapted themselves to American conditions and American customs, and how it happened makes another part of the long and complex history of the *Rickettsia*.

In New York City there once lived a physician named Nathan E. Brill. He was a general practitioner and he had practised medicine capably and uneventfully for many years. Then in 1898, something happened. Many patients came to Dr. Brill complaining of illness and fever, severe headache and spots on the body. Now, Dr. Brill knew nothing of the *Rickettsia*—they had not yet been discovered—but he knew typhus fever.

"What is this?" thought Dr. Brill. "It must be an epidemic of typhus fever, but how can it be? Is it or is it not? To be or

not to be," said Dr. Brill, who was fond of Shakespeare. "It's a kind of typhus fever, but where the lice? Typhus fever must have lice to carry it from one patient to another."

So Dr. Brill asked embarrassing questions which only a courageous physician dares ask, questions such as, "Do you itch, sir (or madam)?" or "Do you sleep with anyone who itches? And your wife, or husband, or your boy friend or your lady friend—do they itch? Do any members of your family habitually scratch themselves?" And more questions of that sort.

Then Dr. Brill had his patients remove all their clothes, leaving them to wait naked and shivering in the examination room while he himself examined their clothing in the dressing-room, using a powerful magnifying glass to inspect the seams.

The answers to his questions and the results of his examinations were the same—no lice! Positively no lice! It was typhus fever without lice!

So Dr. Brill reported this strange disease in the *American Journal of Medical Science*. In effect he wrote, "I do not know what this disease is, but it must be some strange form of typhus fever." And by confessing his ignorance, the mark of an intelligent and sincere man, he had stated the problem clearly.

Nearly fifty years later, the mystery of Brill's Disease was explained.

Many years ago, the germs of European typhus fever came to America, crossing the ocean inside the bodies of immigrants. Once arrived on these shores, the immigrants adopted American ways and got rid of their lice—in America it is disgraceful to be lousy. In a sense, the germs also adopted American ways. Unable to find lice by which to be carried from one human to another, they did something very strange. It was the strangest thing that deadly germs of disease can do. They did nothing!

The germs of deadly European typhus fever lived quietly inside the bodies of naturalised Americans, where they slept for twenty or more years. Since they caused no illness, the hosts did not even know that they carried the germs. Then the germs must have done something awkward; perhaps they yawned and stretched in their sleep, perhaps they awoke—our science does not know how it happened—but the germs "set off the burglar alarm." The human-body toxins sounded, the human-body defences mobilised, the germ-killing antibodies poured into the blood stream, the watchdog phagocytes growled and snapped at the germs—after twenty years of indifference. Then disease flared with illness and headache, and the germs were destroyed. For, during the heat of the conflict, they were driven into the blood and skin, and since there were no lice to

carry them off to other human bodies, it was Dunkirk for the germs. So these germs of typhus fever and Brill's Disease were exterminated.

Each state of the union seems to have its own peculiar brand of germs and disease; each state has a medical history uniquely its own. New York had its Brill's Disease and Texas would not be left behind.

In the state of Texas is Camp Bullis, and there in 1943 suddenly several hundred soldiers became ill and feverish, complained of severe headache and of spots all over their bodies. It seemed to be a typhus-like disease, so the medical officers looked for germs to cause the disease, for ticks to carry the germs to men, and for larger animals to harbour and serve as a reservoir for the germs. They found the germs and the ticks, but they have not as yet located the reservoir. The ticks are well-known natives of Texas noted for the determination with which they crawl and bite and suck blood. The germs are of course Rickettsia, a new species unrelated to any others and not to be found anywhere else in the world. Lone Star Typhus Fever remains a product exclusively of the state of Texas.

But New York was not to be outdone by Texas. In the winter of 1946, Rickettsia again invaded New York City, arriving unannounced and bringing pestilence upon its terrified citizens. It is true that there were no weepings and wailings and tearing of hair; no torchlighted mobs ran shouting along the darkened streets of Times Square; neither the sound of death carts rattling over the manhole covers nor the cry of "Bring out your dead!" echoed between the skyscrapers; there was only the usual going to and not returning from the cemeteries of Green-Wood and Fairlawn; but there was genuine fear and panic among the city dwellers when Kew Gardens Typhus Fever spread among them.

It began in the borough of Queens among the tenants of a modern apartment house. It began quietly. A small boy complained to his mother; he felt sick and weak, his head hurt and there were spots all over his body. So his mother took him to the family physician and the physician said, "Chickenpox."

(Do not be critical of the physicians. Nearly all New York physicians are very capable, but they cannot all be expected to be Dr. Brills. In recent years, the Rickettsia rarely visit New York and many New York physicians have never seen typhus or typhus-like diseases.)

Then a matronly woman walked into the physician's office with the same complaints as the little boy. Again chickenpox? In a woman in her thirties, who was positive she had had

chickenpox as a child? The physician said, "Chickenpox!" What else could he say?

Then another matronly woman—chickenpox! A young man—chickenpox! Two children and an old man—chickenpox! A grandmother, a mother and a grown-up daughter—chickenpox and chickenpox, a pox on chickenpox, how could they all have chickenpox? But what else could it be? So, thereafter, the New York physicians made no diagnosis, but treated symptomatically, prescribing drugs to relieve fever and deaden the headache, and sedatives to soothe and relax and bring rest and sleep. And, fortunately for everyone concerned, no one died of the "chickenpox."

The months passed and Kew Gardens Typhus Fever continued. Before it ended there were nearly a thousand cases in New York and a few that somehow had migrated to Boston.

It was noted that certain apartments were "haunted" by the pestilence, their occupants certain to be infected. Most families moved out as soon as the "haunting" began, even though apartments in New York were not easy to find. Those who defied the "haunt" and remained were avoided by others. They were received coldly when they visited their friends and relatives and they were puzzled and offended when their visits were not returned.

No one knows how it all would have ended if it had not been for Dr. Charles Pomerantz. (He had no academic honours but, in view of his services, we herewith grant him an honorary doctorate degree.)

Pomerantz was the head of an exterminating service firm, and he looked for and found mice in the basement of the haunted apartment house. And some of the mice were sluggish and some were dead, and many were actively alive. The active mice scrambled among the uncollected refuse, foraged precariously inside the incinerator, leaving hurriedly when it was fired and returning when it had cooled. Mice scurried within the building walls, entered the apartments through holes in the plaster, and one mouse was expelled from the very bed in which a tenant was suffering the pangs of Kew Gardens Typhus Fever.

Then Pomerantz carefully examined the basement, probing in the cracks of the walls and ceilings. He picked through the fur of dead and living mice. And he found mites! They were about the size of the point of a small pin when they were starved; when they were full of blood they had just sucked from a mouse or a man, they were about the size of the head of that pin. Yet Dr. Pomerantz found them! (Has anyone any doubt that he deserves the honorary doctorate degree we awarded him)?

The mites swarmed on the mice and they also crawled on the walls and in the nap of the rugs and carpets and the furniture of the apartments. The mites left the dying mice as the furry havens cooled and crept into warm beds and bit and sucked blood while the tenants slept, and the only signs they left were the inconspicuous "mosquito bites" and the tiny spots of blood that stained the bedsheets. It was the mites that carried Kew Gardens Typhus Fever from mouse to man.

Dr. Pomerantz had done the pioneering; now came many experts to explain and name. They came from the United States Public Health Service, from the Department of Agriculture, universities and colleges, city and state health departments. The mites, they explained, were Egyptian mites, though how they had migrated to Kew Gardens was not mentioned. The mice were just mice, the ordinary household variety. The germs were *Rickettsia*—a new species never seen before anywhere. Kew Gardens Typhus Fever was officially named *Rickettsia* pox, a new disease.

If mice ever need sympathy, then the mice in that apartment house in Kew Gardens needed it. *Rickettsial* pox is a mild disease among humans, but to mice the same disease is deadly and most of the Kew Gardens mice died miserably of virulent mouse typhus fever. The few mice that survived the disease perished soon after, as did the mites and the germs—the experts say it was the most vigorous job of extermination of animal and germ life in an apartment building ever done anywhere in the world at any time. Afterward the illnesses with fever, headache and spots became fewer and fewer until the building once haunted by pestilence again resumed its status as a prosaic apartment house in Kew Gardens with tenants calm and unfrightened, pre-occupied exclusively with their children, the most recent gossip and the ballgame scores.

CHAPTER XX

OF MEN AND GERMS

THE *RICKETTSIA* also cause Q Fever and Q Fever continues unchecked. Fifty thousand cases were reported in the city of Los Angeles in 1950. And Q Fever is more than just a disease.

Over the past two decades, before its mystery had been solved and before it became known as Q Fever, many physicians had observed this strange but not too serious ailment. They discussed it informally among themselves and wrote articles in the medical journals. It seemed to be a typhus-like disease. Yet how could it be? Neither ticks, lice, fleas nor mites could be found in connection with it. The new disease was diagnosed tentatively and vaguely as "Mild Influenza" or "Primary Atypical Pneumonia," but the physicians were uncertain and dissatisfied with their diagnosis.

The same disease, the same uncertainty and dissatisfaction were being reported in other parts of the world. In Greece it was "Balkan Grippe," in Central America "Panama Fever." It was not suspected that, in each case, the illness was caused by the same species of germs. The comparisons and the solution were to come later.

The most persistent reports of the new disease originated in the American Midwest. There it was a strange malady of ranchers and sheepherders, and of labourers in slaughterhouses and in the wool, hair and hide industries. The disease would erupt among livestock handlers in Amarillo, Texas, and then jump north a thousand miles to strike among the packing houses in Chicago, Illinois. Those who were connected in any way with the cattle industry were most frequently infected. It was classified as an "occupational disease"—cause unknown, method of infection unknown, prevention unknown.

On the American West Coast, there are arid spells followed by high winds that blow clouds of dust steadily for hours and days. In California they are known as Santa Ana windstorms, and four or five days after each storm, the new disease erupted. When the location of each case of illness was plotted on a map and marked with a black cross, it was noted that the crosses originated at and clustered thickly around certain ranches and farms, sometimes surrounding a single barn, and that the crosses advanced over the land in a definite path in the direction the wind had blown, becoming fewer and fewer and finally ending many miles from the origin. It was as though the wind had blown a contagious miasma from a malignant focus. The disease and its symptoms were definite, but its cause was uncertain and the physicians called it an "air disease."

In Italy at the close of World War II, American Army Medical officers were embarrassed. They were compelled to report that certain barns were haunted by pestilence. Troops who were quartered in these barns invariably became ill with fever and headache. The medical men finally escaped from their awkward

situation—in their official reports, they referred to the illness as a “place disease.”

A shipment of American agricultural machinery arrived in Switzerland and a few days later an epidemic of a mysterious disease broke out among those who had handled the shipment. The Swiss physicians were completely baffled. They could not even name the new disease, for “agricultural machinery disease” is hardly proper medical terminology.

In the Mediterranean area in 1945 there were eight successive epidemics of a mysterious ailment among American and Allied troops. Each illness was recorded as an “army disease.”

Meanwhile, from England, Italy, Africa, Asia Minor, Spain, the Balkans, Iran, India, Australia and Panama poured a stream of medical reports printed in many languages—case histories of a new disease, its cause, its source, unknown.

Frequently the new disease turned up in the most unexpected locations, as in the very bacteriology laboratories where contagious diseases are customarily brought to be studied by experts. In the laboratories, the scientists and their assistants suddenly reported sick and took to their beds, and coincidentally the employees of nearby laundries also felt weak and feverish and took to their beds. Alarmed by these developments, the National Institute of Health in Bethesda, Maryland, circularised a warning. They urged that, for their own safety, the ordinary bacteriology laboratories make no attempt to study the new disease—it was dangerous, they said; it required special equipment and skills such as those available only at the Institute. Then the disease flared up in the most unlikely place—at the National Institute of Health in Bethesda, Maryland. There were forty-seven cases, and the embarrassed scientists at the National Institute had no idea how the disease entered initially or how it spread from one victim to another.

Now, all these uncertainties and dissatisfactions and embarrassments were unnecessary, for the mystery had been explained several years before. But no one had paid any attention to the explanation; it had been buried in back numbers of medical and public health journals.

The explanation had begun in 1935. Australian bacteriologists had studied an epidemic among the workers in a meat-packing factory in Brisbane, and had discovered and cultured the germs that caused it. They were a new species of *Rickettsia*. But how they spread from victim to victim was not entirely clear, and the germs themselves were puzzling—they seemed able to assume manifold shapes and dimensions. In their uncertainty, the Aus-

traliens named the new disease Q Fever, the Q meaning "query."

A few years later, American bacteriologists investigated a strange illness that had arisen near Nine Mile Creek in Montana. They found strange germs causing this illness—it was a new and unusual species of *Rickettsia*, they reported—and they called the disease Nine Mile Fever.

Americans and Australians eventually compared notes, each supplying the details the other lacked, and they agreed that the germs and the diseases were alike—Q Fever and Nine Mile Fever were identical. Since the Australians had priority in date of first discovery, the name they selected was adopted, and Q Fever was added formally to the numerous diseases caused by the many species of the *Rickettsia*.

For the next few months, bacteriologists and physicians all over the world engaged in studies and comparisons, and then all became clear. All the new diseases, "Balkan Grippe," in Greece and "Panama Fever" in Central America, all the unnatural pestilences were caused by the same species of germs that had been shown to be responsible for Q Fever.

The germs of Q Fever contaminate milk, cheese and butter. They resist the heat of pasteurisation and spread "Mild Influenza" and "Primary Atypical Pneumonia" among the dairy-men and the consumers of dairy products in California. They permeate the flesh and bones, hide and hair of slaughtered cattle and bring "occupational disease" to the men and women who work with animals and animal products in the American Midwest. The germs may be scattered and dried to a powdery dust but they continued to live and they retain all of their virulence. This was the dust that haunted barns in Italy to plague the American troops with "place disease," that infected the soldiers in the Mediterranean area with "army disease," that was blown by Santa Ana windstorms spreading "air disease" over California.

From a Q Fever-infested barn in America came the straw in which agricultural machinery had been packed, and, when the Swiss unpacked the machinery and inhaled the dust from the straw, they sickened with "agricultural machinery disease."

Carcasses of diseased animals were carried into the laboratories of the National Institute of Health to be dissected and studied, and the germs in the animal flesh infected the scientists and their assistants with Q Fever. The animal blood and fluids splattered their gowns and towels, and the laundry was invaded by the same germs and the workers overcome by the same disease.

These germs are extraordinary; they are remarkably adapt-

able and incredibly vigorous. They can assume any size and any shape, sub-dividing into almost invisible granules as small as the smallest of the viruses, or growing out into large coarse filaments, but in any form their virulence remains undiminished. They can infect any species of animal and from the animal body leap to man, or they can infect man directly and spread disease from man to man without recourse to lower animals. The full account of their potentialities still escapes the formulæ of science and medicine.

For within each of the Rickettsia, nature has instilled a remarkable instinct. It drives them to aspire toward a life of ease inside an animal body, to infect without causing the virulent disease that means death for both host and germs. It drives them toward higher and higher forms of life.

Many millions of years ago, the Rickettsia lived only on plants as parasites, infecting the plant juice and using it for their food.

Then millions of years passed and plant lice evolved. The lice sucked juice from the plants, and some of the Rickettsia in the plant juice left the plants and infected the plant lice.

More millions of years passed and more animals evolved. The plant lice, some of them, changed into animal lice. And some of the Rickettsia went with the plant lice and became parasites, first on animal lice and later on larger animals that the lice infested.

Today many animals harbour certain species of the Rickettsia. The germs pass on to each animal generation in turn and the animal offspring carry the germs even before they are born. Today many species of lice, ticks, fleas, mites, rats, squirrels, deer, cattle and many many others carry the Rickettsia within their living protoplasm. There is no disease, no antagonism between parasite and host.

The lower animals have been conquered by certain species of the Rickettsia; the germs of Q Fever are the form devised by blind and powerful nature for the conquest of man. The germs of Q Fever seek a parasitic utopia inside the human body; their purpose is to conquer, not to kill. The germs of Brill's Disease lived in the human body for twenty years or more without arousing disease; these new germs of Q Fever are as superior to the germs of Brill's Disease as the first men of the Neolithic era were to the brutish Paleoliths.

We and our science may interfere with miracle drugs and sera and vaccines, divert the plans of nature and upset the aspiration of the germs of Q Fever. Or we may fail. Many hundreds, perhaps thousands, of years will elapse before the outcome is certain. If nature's plan succeeds and our science is

unable to prevent it, then the men of the far future will accept the germs of Q Fever within their bodies. Future generations of men may even have forgotten that these once were alien germs. Perhaps nature's plan has already been fulfilled—from free living to plants to lice to rats to *Homo sapiens*. Perhaps the aspiring germs of Ricketts are now established permanently within the protoplasm of humans who have been infected with Q Fever!

Q Fever is more than just a disease; it is the key to a law of nature.

When a small boy throws a stone, when an apple falls from a tree, when the moon moves around the earth and the earth around the sun—these are commonplace events, but behind them are nature's laws of motion, the laws that Isaac Newton described. Behind the trivial illness caused by the germs of Q Fever and the innumerable diseases caused by the Rickettsia and by all the other germs of disease is another law of nature, a law that has not yet been described. It awaits another Newton. It is the law of the evolution of the host-parasite relation.

In the golden dawn of creation, the germs multiplied into great numbers and the world was a world of germs, living freely and independently and indebted to no other form of life for their survival.

Eons passed, and plants and animals arrived to share the world with the germs. And some of the germs changed, losing their freedom and independence, becoming parasites that lived on plants and animals and, when men appeared, on men.

Now, there must be a beginning to everything, just as ultimately there must be an ending. On a world that still was jaggedly raw and steaming, a parasite aspirant made the very first leap to the body of another kind of life. It was a momentous leap. It foreshadowed our ailments of heart and lung and bowel and blood, our coughs and fevers and chills, our aches and sweats, our shrivelled limbs and ugly sores and gasping throats and the shame of our love diseases. It foreshadowed all our pestilences and plagues.

That first leap was made while the world was young. Since then, millions upon millions of many kinds of germs from the soil, water and air have leaped from free-living existence toward parasitism. And they continue to leap. But they are novice parasites and very few of them survive; they destroy themselves with impetuosity and ineptness. For the protoplasm of each kind of life instinctively resists intrusion by another kind of life. Invaded

protoplasm responds with certain signs and symptoms that describe its resistance against invasion, and the signs and symptoms are known as disease. Novice parasites, being youthful and brash and over-eager, arouse violent illness and death. Sometimes, after a bitter struggle, the beleaguered host destroys its novice parasite; frequently host and parasite die together, first the one and then the other. It is the novice parasites that cause all our deadly pestilences and plagues!

For, though it is true that living protoplasm is reluctant and instinctively resists intrusion by alien life, a skilful parasite can evade resistance and overcome reluctance; it arouses no violence, the host is spared, and the host and parasite both continue to live. But it takes many thousands of years for nature to change a novice into a skilful parasite.

As the earth grew older, a few species among the novice parasites acquired skill and they survived. They learned subtleties that come with an ancient lineage, how to control their crude eagerness and avidity, how to restrain their urge to increase into vast numbers, how to enter and leave unobtrusively and never betray their coming and going. The diseases they aroused grew milder and lasted longer.

After many years of selection and evolution, the germs cling more and more stubbornly to the foreign protoplasm they have selected. They can be neither driven out nor destroyed, for they have penetrated too deeply into the innermost recesses of the alien protoplasm. They are able to remain hidden indefinitely, alive but inert, no longer arousing disease. Imperceptibly they merge more and more completely with the protoplasm of their host, until each loses its identity. Then there are no longer two species, *parasite* and *host*; there is only the single species, *host-parasite*!

This is the law that nature has decreed. All of her germs of disease are aspiring germs; to survive in their struggle for existence they must adapt and change and eventually and inevitably merge with and become a part of that species of life to which they once brought illness and death.

Within the protoplasm of our living cells, there is a miscellany of small strange particles that vaguely resemble bits of string, or tiny spheres, or miniature corkscrews. And ever since the microscope was discovered, many generations of scientists have peered and pored over them and disputed their significance. Some claim that these particles in the human protoplasm are extremely important, possessing certain vital (but unspecified) functions, while others believe that they are trivial with trivial functions.

And still others insist that these particles have no function at all, that they are shadowy "nothings" that exist only in the overwrought imaginings of over-enthusiastic scientists, or as imperfections in their microscopes, their straining eyes or their laboratory technique. Although the embattled scientists agree neither on the status nor the functions of these protoplasmic particles, they are compelled to agree at the least on a *casus belli*, even if only to deny that it exists. The most bitter opponent of their existence must call these strange particles something, and so some of them have been named—*centrioles*, *mitochondria*, *nucleoli*, *plastids*, *vacuoles*, *inclusions*, *Golgi network*, *granules*, *globules*, *filaments*, *fibres*, *fibrilles*, and "*ad infinitum*."

There are other scientists who study human protoplasm in quite another manner and are completely uninterested in the particles within the human living cells. From their researches on immunity to disease, they have deduced that certain germs (the viruses of poliomyelitis, for example) first infect and cause disease and thereafter never leave the human body. Then the germs no longer cause disease, but they remain alive though inert for a human lifetime.

There is still another school of scientists who probe into the disputed interior of human living cells. They have discovered that they can extract germs from healthy uninfected, undiseased human cells. The germs they extract are alive and will grow on human tissue, but never cause disease. The scientists are convinced that there are always living germs buried deeply within human protoplasm.

Perhaps the many strange particles within our protoplasm are derived from ancient germs of disease that in turn are descended from other germs that once had lived freely and independently. Perhaps in the remote past the ancestors of these protoplasmic particles had attacked and infected and reinfected, killed and been killed over and over again, as innumerable generations of germs and men collided in innumerable episodes of disease and death. Perhaps, with the passing of eons of time, the antagonists became reconciled and, one by one, each of the many kinds and varieties of disease germs turned into harmless and familiar enemies. And as they sank deeper and more intimately into human protoplasm, they may have joined others who had gone before. And more protoplasmic particles accumulated as mankind grew older.

The straight and curved bits of string, the tiny spheres and the peculiar corkscrew shapes with many names and unknown qualities resemble vaguely the rod shapes of the genus *Bacillus*, the spirals of *Vibrio* and *Treponema*, the spheres of *Staphy-*

lococcus and *Streptococcus*. They may be a blurred recording of bygone eras, a narrative in nature's hieroglyphics of pestilences and plagues that tormented man far back in the past but now no longer exist.

If we have correctly interpreted nature's law, then all our disease germs will change from antagonism to co-existence, and turn from dangerous bits of alien life into inconspicuous particles within our living cells. Perhaps far ahead in the future in a disease-free world, the descendants of germs and men will live together harmoniously in a mingling of protoplasm—a perfect symbiosis of men and germs.

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